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## **Operating Instructions**

### **DB05**

*Thermal mass flowmeter  
and Controller for gases*

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## 01 Welcome

With *DB05* you get the latest, most modern CMOS sensor technology. CMOSens™ is a technology label and stands for a modern process in which the sensor and the signal processing are combined on a highly integrated chip.

This manual will familiarize you with the installation and operation of your *DB05*. We therefore ask you to read this manual carefully and to contact your sales partner with any questions or doubts.

We have prepared this manual very carefully in order provide you with appropriate and precise information and instructions. However, no liability is assumed for any errors.

### **User Benefits**

Ultimately, a technology only represents a means to an end. Therefore all of our efforts are aimed at the requirements and wishes of the user of this instrument and his measurement and regulation tasks:

- *Compact, easy-to-install measurement or regulation unit*
- *Normalised input and output signals*
- *Normalised supply voltage*
- *Serial communication*
- *CE approved*
- *Measurement of the gas temperature*
- *Easy maintenance and service*
- *Easy expansion of functionality*
- *3-year guarantee*
- *Top performance in response, dynamics and accuracy*
- *Matching options and accessories*

### **Service and Quality**

We continuously improve the quality of our products and services. Only with use does it ultimately become clear whether the right product has been selected. Thus, we attempt not only to propagate good service and high quality, but to live it every day.

### **Guarantee**

The guarantee for *DB05* or *gasflow* products extends to material defects and production flaws. The guarantee maximum is the replacement of the equipment at no cost. Claims are omitted in the case of inappropriate use, external effects in general, excessive heat or dropping.

We are always grateful for information on existing defects, for suggestions for improvements, and for critiques.



## ***Tips and Warnings***

Before putting the instrument into use, these operating instructions should be read thoroughly. Improper use, errors for lack of understanding and the consequences arising from this, can lead to the destruction of the instrument or even the endangerment of personnel.

The equipment should be put into operation and serviced by appropriately qualified personnel only. The proper handling of the products is an absolute requirement for its trouble-free operation.

Electrostatic discharges can destroy electronic components of this measurement and regulation unit.

This manual aims at a safe operation of *DB05* mass flow meters and controllers. Each instrument is supplied full of charge with a CD containing the *DB05* software as well as this manual.

## 02 A Bit of Theory

### Measuring Principle

The principle of thermal mass flow measurement is perfectly suited for the measurement of gas flows. One of the significant advantages is that the measurement is largely independent of pressure and temperature. By contrast to volumetric principles, pressure and temperature do not have to be additionally measured. Although the principle yields mass as a measurement result (e.g. g/min), most devices are calibrated to standard volumes (e.g. l/min). One possible explanation is the fact that the comparability of the measurement results with other principles is given with this. Since the thermal flow measurement depends on the type of gas, in addition to the specific heat, the standard density (0°C, 1,01325 bar a) for the conversion to standard volume is also used.

With all design options of the measuring principle, there is always a heater and one or more temperature-measurement points and the gasflow draws heat from the heater.

With the DB05 mass flow meter, a constant heating power ensures a temperature difference that is directly proportional to the gas flow rate. In the flume, a temperature measurement is followed by a heater, and then a temperature measurement again. The figure below illustrates this process. If the flow rate=0, the heater H uniformly distributes the heat, for which the temperature difference T1-T2 equals zero. Two effects occur with the flow rate that lead to a temperature difference: First, the temperature sensor T1 at the entrance detects a lower temperature. This happens because of the cooling of the entering gas, which theoretically drops to the ambient temperature respective of gas. Secondly, the gas flowing over the heater carries heat to the temperature sensor T2, located after the heater, and thus increases this temperature. The temperature difference is in direct proportion to the mass flow.

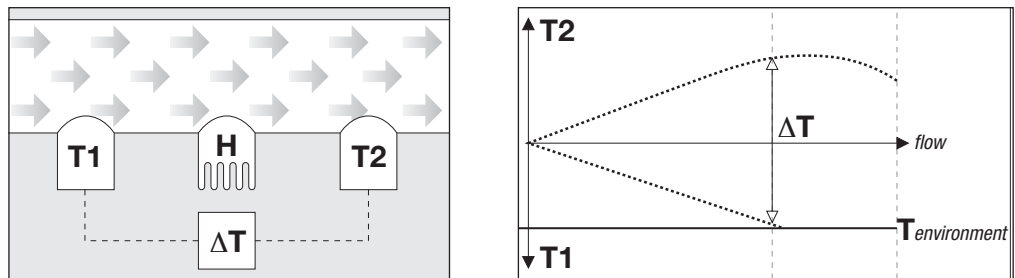


Figure 2: Schematic illustration of how thermal mass measurement functions

### CMOS Technology

DB05 measurement and regulation units feature a new basic technology that sets standards for maximum precision sensor systems. The fusion of a semi-conductor chip with sensor technology results in a highly integrated system solution that is impressive for its excellent sensor precision, as well as digital intelligence and reliability.

The most notable advantages to the customer are the outstanding precision of the sensor, the rapid response time and a dynamic measuring range that no system has attained up until now. Thanks to the compact single chip design, CMOSens™-based sensors are extremely resistant to electromagnetic interference (EMI), a significant technical advantage of this ultra modern sensor technology.

With CMOSens™, the sensor element, amplifier and A/D converter form a unit on the same silicon chip.

# Mode of Operation

The digital intelligence linked with the CMOSens™ sensor permits the emission of a fully calibrated, temperature-compensated output signal. The CMOSens™ 'intelligence' integrated onto the chip thus facilitates an extremely simple processing of the emitted measurement data. CMOS is a standard technology for the manufacture of integrated circuits.

CMOS chips are generally known as 'semi-conductor chips', 'silicon chips' or 'computer chips'. They are widely used in PCs, mobile telephones and many other information technology devices.

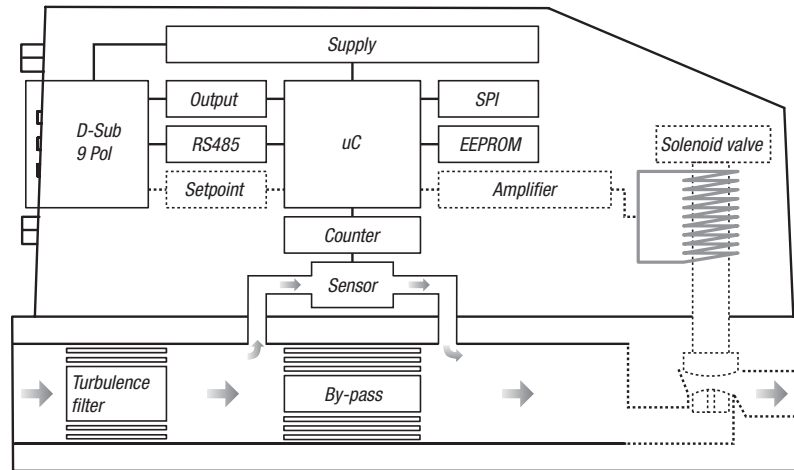


Figure 2: Block diagram of the hardware

## 03 Technical Informations

### General Specifications

#### Accuracy

Standard

+/- 1,5% of full scale

Hi-Performance

+/- 0,5% of full scale

#### Dynamic range

Standard

3,5 – 100 % within specified accuracy

Cut-off < 2% of full scale

Hi-Performance

1 – 100 % within specified accuracy

Cut-off

#### Repeatability

+/- 0,1% of full scale

#### Longterm stability

< 1% of rate/year

#### Temperature sensitivity

-

#### Pressure sensitivity

< 2%/bar (typical N2)

#### Control stability

+/- 0,1% of setpoint

#### Operating pressure

Up to 10 bar

#### Operating temperature

0 – 50°C

#### Leak integrity

Inboard/outboard

1 x 10<sup>-8</sup> mbar l/s He

Control valve

1 x 10<sup>-6</sup> mbar l/s He

#### Warm up time

30 min for max. accuracy

### Physical Specifications

#### Materials of construction

Model code A (Alu)

Aluminum

Model code E (SS)

Stainless Steel

Sensor

PBT, Epoxy and Silicon

#### Seals

Viton, optional EPDM or PTFE

#### Mechanical connection

Up to 50ln/min G1/4"; up to 200ln/min G1/2"

female inlet and outlet

optional with fittings

#### Electrical connection

9-pin sub-D connector (male)

#### Ingress protection

IP-50

### Electrical Specifications

#### Supply voltage

+ 24 Vdc -5% / +10%

#### Supply current

Massflow meter

max. 100 mA

Massflow controller

max. 250 mA

#### Analog setpoint

Voltage

0 – 5 V, 1 – 5 V, 0 – 10 V

Current

0 – 20 mA or 4 – 20 mA

Max. load

500 Ohm

#### Digital communication

RS-485, Modbus RTU protocol

#### Control parameters

Freely adjustable by digital communication

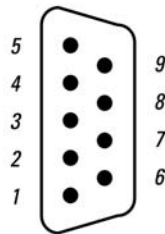
## Measurement Ranges

The DB05 massflow meters and controllers are normally supplied with one of the following standard measuring ranges for air. Optional the instruments are available with a customer specific range and calibrated for a different gas.

### Standard ranges

| Code | Range | Unit    | Code | Range | Unit   |
|------|-------|---------|------|-------|--------|
| A1   | 25    | mln/min | C2   | 5     | ln/min |
| A2   | 50    | mln/min | C3   | 10    | ln/min |
| A3   | 100   | mln/min | C4   | 20    | ln/min |
| A4   | 200   | mln/min | C5   | 50    | ln/min |
| A5   | 500   | mln/min | D2   | 50    | ln/min |
| B2   | 500   | mln/min | D3   | 100   | ln/min |
| B3   | 1000  | mln/min | D4   | 200   | ln/min |
| B4   | 2000  | mln/min |      |       |        |
| B5   | 5000  | mln/min |      |       |        |

## Pin Configuration



|          |                        |                       |
|----------|------------------------|-----------------------|
| <b>1</b> | Ground Analoge Signale | <i>Common (-)</i>     |
| <b>2</b> | Ground                 | <i>Supply 0 Vdc</i>   |
| <b>3</b> | Supply + 24 Vdc        | <i>Supply +24 Vdc</i> |
| <b>4</b> | Analog output          | <i>Output (+)</i>     |
| <b>5</b> | Analog setpoint        | <i>Setpoint (+)</i>   |
| <b>6</b> | RS-485 Output (Y)      | <i>Tx+ RS485 (Y)</i>  |
| <b>7</b> | RS-485 Output (Z)      | <i>Tx- RS485 (Z)</i>  |
| <b>8</b> | RS-485 Input (B)       | <i>Rx- RS485 (B)</i>  |
| <b>9</b> | RS-485 Input (A)       | <i>Rx+ RS485 (A)</i>  |

## Analog Signals

The analog output signal, linear to the mass flow, is available between pins 4 and 1.

The analog setpoint signal, linear to the mass flow, is applied between pins 5 and 1.



### Note

Use separate cables for signal ground pin 1 and power supply ground pin 2 to avoid interference problems.

Voltage signals have to be specified on order, or configured by an authorised sales partner.

The voltage output signal is generated by a 250 Ohm shunt resistor.

## Serial Communication

Serial communications with Modbus protocol are a standard feature for the configuration and readout of the instruments.

### Note

The power supply for the analog signals and digital communications must have a common ground potential.

## Calibration

Each instrument is tested and calibrated on a fully automatic calibration equipment, traceable to european and american standards and the calibration data are stored in the non-volatile memory. As standard the calibration gas is air. Please consult your sales partner for calibrations with other gases.

The configuration and calibration data of each individual instrument are available on request.



## Conversion Factors for other Gases

For gases other than air the calibration data are automatically converted to the requested gas. If the measured gas differ from the one the instrument has been calibrated for, the correct output signal can be calculated by means of the relevant conversion factor (see chapter 11).



### Note

*Depending on the gas measured, conversion factors may introduce considerable inaccuracies.*

The reconfiguration to an other gas is more accurate by using the software supplied with each instrument. The software reads the calibration data from the instrument, converts them to the new gas and reloads them to the instrument.

## Pressure Loss

The pressure loss in a thermal massflow meter is very small and depends on the gas, the operating pressure and the actual flow rate. The graphs in chapter 11 'annex' show typical values for different gases at 20°C and 1013 mbar

The pressure loss for a gas other than air is calculated according to the following formula:

$$\Delta P_{required} = \Delta P \times \sqrt{\frac{\rho_{required}}{1.250}}$$

Note that insufficient tube diameter or unsuitable fittings may cause a high pressure loss.

The pressure loss in a massflow controller mainly depends on the control valve. The control valve must operate with the specified pressure drop for proper operation.

The graphs in chapter 11 'annex' show the typical pressure loss in massflow meters of different sizes and with different gases.

## Temperature Compensation

Thermal massflow meters are almost unaffected by temperature and pressure variations of the measured gas. The temperature variations are detected by the sensor. Based on a three dimensional correction table the microprocessor then automatically corrects the output.

The temperature is measured with an accuracy of +/-0.5°C and can be read-out over the serial link.

## Pressure Compensation

Each individual instrument is calibrated for the specified working pressure. Changing pressure conditions degrade the accuracy.



### Note

*The proper function of a flow controller is not guaranteed if the pressure drop is too high or too small.*

## Response Time

A unique feature of the CMOS-sensor is the extremely fast response time of 5ms. After 10ms the measured value is within its standard accuracy of +/-2%. After 1.2s the maximum accuracy is attained.

## ***Control Characteristics***

The control characteristics of the DB05 massflow controllers can be adapted to the application. 3 sets of control parameters are factory programmed for the following control response:

*Parameter set U: Fast response with overshoot*  
*Parameter set V: Optimal response with slight overshoot (standard)*  
*Parameter set W: Slow response without overshoot*

2 additional sets of control parameters are user programmable should none of the preprogrammed ones be acceptable.

## 04 Mounting and Installation

### General Informations

Check the packing box for damage. Should the packing be damaged, immediately notify the local carrier and inform your sales partner.  
Carefully check if the goods correspond to the packing list and that there are no missing or damaged parts.  
For best performance carefully read the following recommendations.  
Check the instrument label and make sure that the massflow meter/controller suits the application.



### Caution

*The maximum working pressure must always be lower than specified test pressure.*

### Mounting

The preferred mounting position is horizontal, up right or hanging. For pressures > 5bar a vertical mounting position may cause an offset.  
Avoid the installation in proximity of any source of thermal or electric radiation.  
Avoid vibrations and mechanical stress.  
Do not install the instrument at the lowest point of the piping to avoid an eventual backflow of liquids.

### Piping

The correct piping is very important for the performance of measurement. Therefore carefully check the following points:

*The piping must be absolutely clean.*

*The piping must conform in pressure and corrosion resistance.*

*Always fix the instrument on the body by means of fixing screws.*

*Avoid abrupt angles on the inlet. If this is not possible contact your sales partner.*

*Use appropriate fittings with O-ring seals and do not tighten the fittings holding the instrument by the cover.*

*Never use liquid sealing as it may flow into the instrument.*

*Do allow a sufficient upstream buffer volume between the pressure regulator and the instrument, especially with higher flow rates.*

*Do not use too small diameter piping as this creates a high pressure loss and may impair the performance of the instrument.*

*Carefully check the piping for possible leaks.*

*The instruments have a flow rectifier at the inlet. For flow rates > 50ln/min a straight tube of 10 times diameter is recommended.*

*For critical applications (uninterrupted gas supply) we recommend to install a bypass system to allow service on an instrument.*

### Electrical Connection

We strongly recommend our standard cables. Please consult your sales partner.  
If you install your own cables, carefully read the connection instructions.

*The installation has to comply with all relevant safety and EMC regulations.*

*We recommend the use of an EMC filter if the power supply cable exceeds 3m.*

*Avoid earth loops.*

*The power supply voltage must be 24Vdc  $\pm$  10%.*

*Use cable of sufficient size to minimize the voltage drop.*

## ***Gas Supply***

Make sure your gas supply is absolutely clean, i.e. free from dust, oil, water etc.

If necessary install an upstream and eventually a downstream filter to avoid any damage to the instrument.

The capacity of the supply should be at least 2 times of the max. flow range.

Carefully choose your pressure controller and do not install your *DB05* directly to it.

The pressure must be sufficient to cover all pressure losses in the piping, fittings etc.

At very low flows the pressure controller might be oversized and work in an intermittent mode resulting in a strongly oscillating flow.

Do not apply pressure until the electrical connections are made. When applying pressure to the system, increase the pressure gradually and avoid pressure shocks.

If explosive or aggressive gases are to be used, purge the process with dry inert gas like Nitrogen or Argon.

## 05 Operation and Service

### Heat-Up Time

Right when the device is turned on, *the DB05 is ready for use*. For the most precise measurements, however, in 30 minutes (option of external feed). Before turning on, please be sure that the wiring is correct and is installed according to the installation plan, and that the gas connections are also mounted in accordance with the installation instructions of the manufacturer.

### Zero Point Check

Without any special specifications for the installation position of the device, the zero point is aligned at operating temperature and horizontal installation position before delivery. If the device is installed vertically, a value can be read out at a zero flow rate according to operating pressure. During the check, be completely sure that no gas is flowing. In the case of a shift in the zero point, please contact your sales partner.

### Service

With proper operation, *DB05* does not require any routine service at all. If the measurement value is in a quality-relevant range (e.g. ISO 9001), we recommend a periodic check of calibration. The interval depends strongly on use.

### Cleaning in the Case of Contamination

Should there be suspicion of contamination (sudden deviation of measurement value in familiar processes, visible traces in the piping, etc.), try flushing the device with a dry inert gas. Depending on the contamination, it may be necessary to dismantle the device.



#### Tips

- Use only designated tools.
- Handle the device and individual components with extreme care.
- Ensure that the dismantling area is clean.
- The guarantee lapses at all events with the dismantling of the device.
- Never loosen a torx screw.
- Do not touch the electronic circuit board or electronic components under any circumstances.
- After the cleaning, you should have the device checked by your sales partner at the first opportunity.

#### Dismantling the flow module *(also see sketch on the next page)*

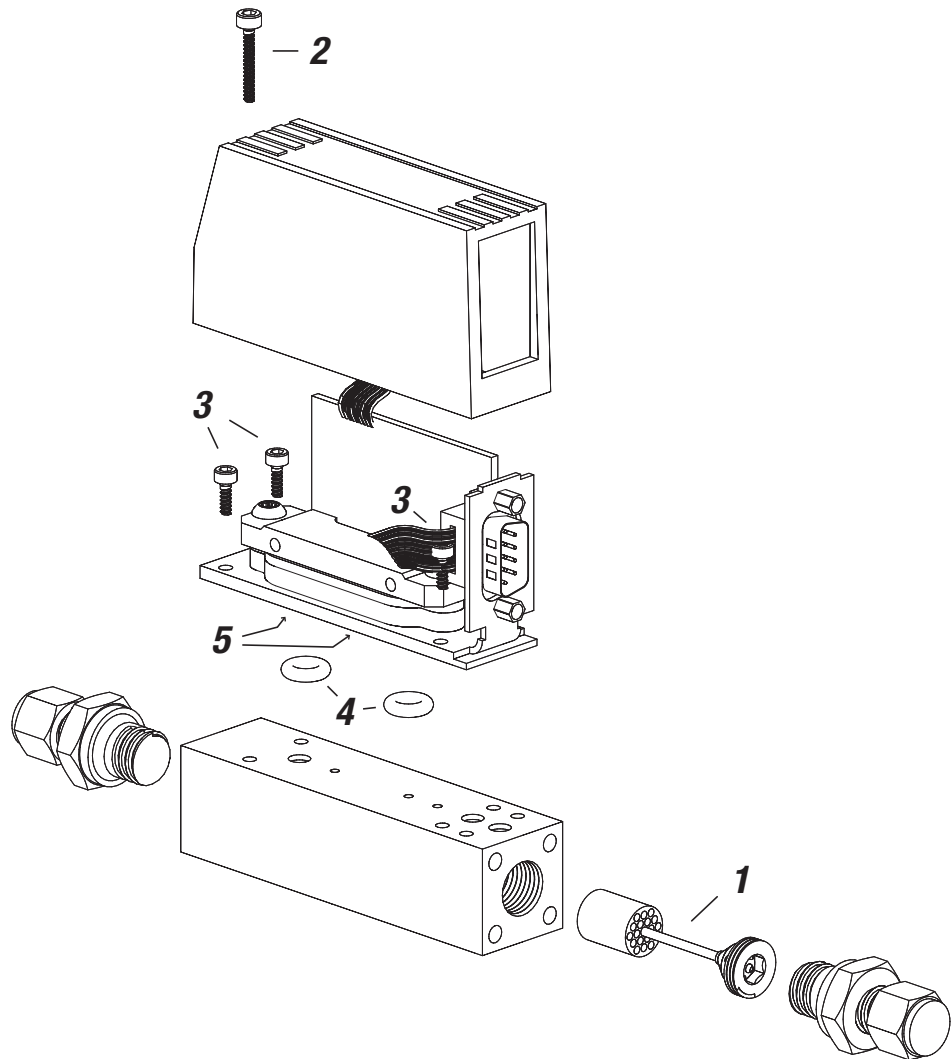
- Dismantle the gas and the electric connections.
- On the feed side, carefully turn out the flow divider together with the flow resistor [1].  
The construction does not have any O ring seals in this section. You can now clean the complete flow module with a light solvent (e.g. IPA).  
Please make sure that the drill holes are all absolutely clean, dry and patent.

#### Dismantling the measuring unit *(also see sketch on the next page)*

- In order to clean the measuring part, first dismantle the central fastening of the electronics casing with an Allen key (4 mm) [2]. Slightly lift up the red casing on the screw side and press it towards the electronics plug. The L-shaped sensor carrier is screwed onto the body with four Allen screws (4 mm) [3]. Once you have loosened the screws, you can lift the carrier off the body.  
Please note that there are two O ring seals on the bottom side of the sensor carrier [4]. Now clean the measuring unit by letting dry gas flow into one of the measuring channel openings sealed by the O rings [5] or carefully rinse the channel with a suitable solvent (e.g. IPA). When doing so, hold the complete sensor carrier in such a way that liquid can never penetrate the system.
- After cleaning the system, make sure to rinse it with dry gas until the measuring channel is also completely dry.

## **Cleaning the body** (also see sketch below)

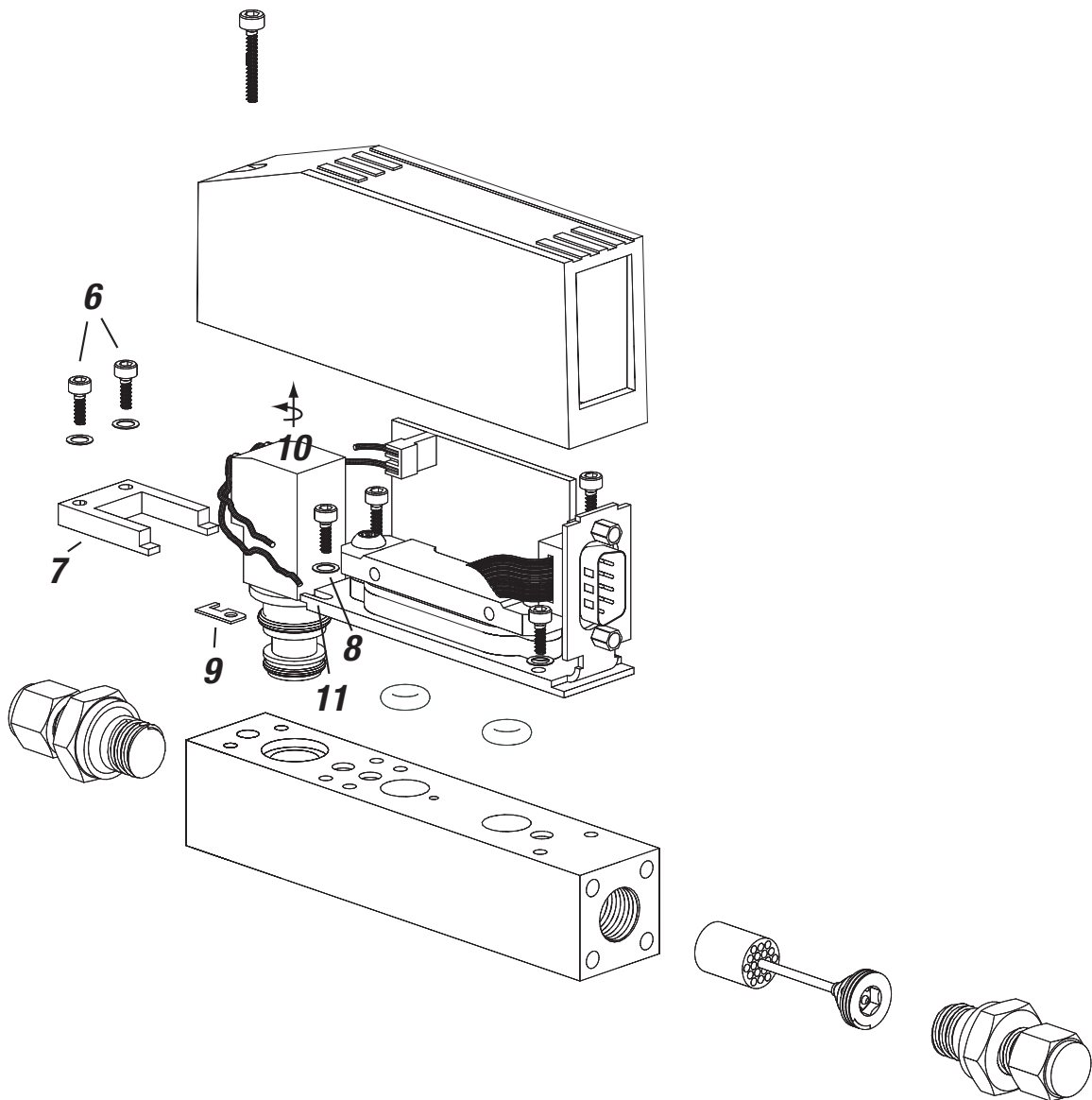
- In case the body is contaminated, dismantle the instrument as described for dismantling the flow module and the measuring unit and clean this also. Please make sure that no residues of cleaning liquids and cleaning cloths etc. remain in the body.
- With the subsequent assembly of the sensor carrier, observe the correct position of the two O ring seals between the sensor carrier and the body under all circumstances [4]. Make sure to screw in the flow module [7] up to the mechanical stop.
- After correct assembly, rinse the DB05 once again with dry inter gas.
- By means of empirical values, check the correct function of the cleaned measuring instrument, e.g. by checking the zero point.



## **Disassembly of the control valve** (also see sketch on the next page)

- Disassemble the gas and the electric connections.
- Make sure that there is no gas pressure in the pipe system or the instrument itself.
- In order to clean the measuring part, first dismantle the central fastening of the electronics casing with an Allen key (4 mm). Slightly lift up the red casing on the screw side and press it towards the electronics plug.
- Now carefully pull out the valve plug. Make sure you do not touch any electronic components on the circuit board.
- Loosen the two Allen screws [6], which hold the U-shaped clamp [7] at the valve. After you have removed the screws, you can pull the clamp away towards the gas output.
- Slightly loosen the Allen screws [8] so that you can turn the metal part [9] diagonally to the outside.

- Carefully pull the valve insert [10] upwards. Slight diagonal turning supports the dismantling process.
- Carefully reinstall the new valve insert with the cable outlet towards the electronic circuit board. Please be careful not to damage the O ring seals on the valve insert.
- Assemble the U-shaped retaining clamp with the 2 screws.
- Guide the valve cable into the recess of the sensor carrier. With the metal part, affix the valve cable in this sector.
- Reinsert the valve electronically.
- Please make sure that the valve cable is not squashed in the area of the duct/recess when assembling the electronics casing.
- After assembly of the control valve, it may be necessary to readjust individual control parameters (especially the parameter 'non-linearity N').



## **Returns**

With the return of a measurement or regulation device, use the original packaging if possible, or other appropriate packing. Please inform us of the reason for the return in order to spare any unnecessary callbacks and delays.



***Should the device come in contact with dangerous substances, please clean the device carefully, notify us and pack the device tightly.***

***Please fill out the contamination statement. You will find this in the chapter 11 'annex' or on the enclosed CD.***

If you have any further questions, please contact your sales partner.



## 06 Digital Communication

The digital communication with a DB05 mass flow meter or controller offers the following advantages:

**More informations.** Besides the mass flow you can read the gas temperature, total flow, alarm status, serial number etc.

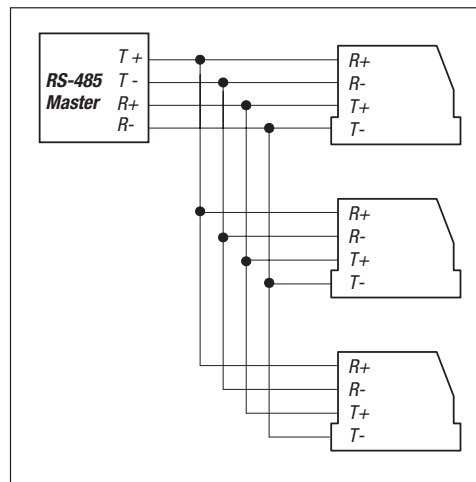
**Access to control functions.** Allowing you to adapt the controller behavior.

**Save cost.** Due to a bus structure within a system of several instruments.

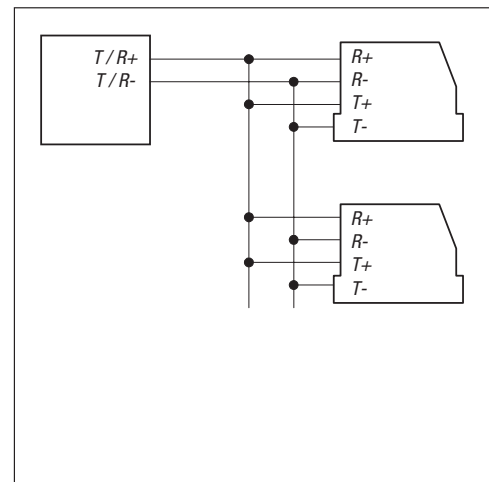
**Higher RFI immunity.**

### Type of Communication

DB05 mass flow meters and controllers work on a serial communication RS-485 with a protocol Modbus RTU. A 2 or 4 wire connection is possible.



**4 wire communication**



**2 wire communication**

Using a RS-485/RS-232 converter the instruments can also be connected to a RS-232 port of a PC. The converter should be galvanically isolated.

With a special cable according to the diagram in chapter 9 'accessories' a DB05 connects directly to the RS-232 port of your PC. This item is also available from your sales partner.

### Notes

*The special cable contains a resistor network to adapt the signal level to the RS-232 port.*

*In some cases it may impair the function of the serial port.*

*Each DB05 must be set to an individual address between 1 and 246 in order to communicate properly with your PC. With the free software you can check the bus, read and if necessary change the address of an instrument.*

## Modbus RTU

The Modbus protocol is a communication structure for a master-slave communication between intelligent instruments. It is used world wide and supported by most manufacturers of measurement and control instruments. Originally it was introduced by MODICON. For further informations see <http://www.modbus.org/>.

For further programming examples please contact your sales partner.

The hardware typically used for Modbus is RS-485, RS-422 or RS-232. A Modbus message from master to slave consists of: Address, command (read or write), data and checksum.

DB05 works on the following communication parameters:

|                         |                |
|-------------------------|----------------|
| Communication speed     | 9600 Baud      |
| Startbit                | 1              |
| Databits                | 8              |
| Stopbits                | 2              |
| Parity                  | none           |
| Bit Time                | 104,6us        |
| Character Time (11 Bit) | 1,1458ms       |
| Max. buffer size        | 20 Byte (Data) |

Max. number of units (theoretical): 247

## Structure

| START       | ADRESS | FUNCTION | DATA       | CRC CHECK | END         |
|-------------|--------|----------|------------|-----------|-------------|
| T1-T2-T3-T4 | 8 BITS | 8 BITS   | n x 8 BITS | 16 BITS   | T1-T2-T3-T4 |

## START

A message starts with a break of min 3.5 character times.= ca. 4ms

## ADRESS

Address range: 01..247

Broadcast to all instruments: 00 => no answer from the instruments

## FUNCTION Overview

|                    |                           |
|--------------------|---------------------------|
| Function 03:       | Read Holding Registers    |
| Function 06:       | Preset Single Register    |
| Function 08:       | Diagnostics               |
| Function 16 (10H): | Preset Multiple Registers |

## DATA

### Function 03 Read Holding Register

Reads the data from the following registers of a slave. The number and the starting address of the registers are free.

Query:

Data

| <i>Start Adr. Hi</i> | <i>Start Adr. Lo</i> | <i>No. of Points Hi</i> | <i>No of Points Lo</i> |
|----------------------|----------------------|-------------------------|------------------------|
| 8 Bit                | 8 Bit                | 8 Bit                   | 8 Bit                  |

Start Adr: Starting address of registers.

No. Of Points: Number of registers to be read.

Response:

Data

| <i>Byte Count</i> | <i>Data Reg. 1</i> | <i>.....</i> | <i>Data Reg. N</i> |
|-------------------|--------------------|--------------|--------------------|
| 8 Bit             | n Bytes            | n Bytes      | n Bytes            |

Byte Count: Number of bytes retrieved.

Data Reg. N: Register data.

### Function 06 Preset Single Register

Writes data in a register of the slave.

Query:

Data

| <i>Reg. Adr. Hi</i> | <i>Reg. Adr. Lo</i> | <i>Preset Data Hi</i> | <i>Preset Data x N</i> | <i>Preset Data Lo</i> |
|---------------------|---------------------|-----------------------|------------------------|-----------------------|
| 8 Bit               | 8 Bit               | 8 Bit                 | 8 Bit x N              | 8 Bit                 |

Reg. Adr.: Register address.

Preset Data: Register data.

Response:

Data

| <i>Reg. Adr. Hi</i> | <i>Reg. Adr. Lo</i> | <i>Preset Data Hi</i> | <i>Preset Data Lo</i> |
|---------------------|---------------------|-----------------------|-----------------------|
| 8 Bit               | 8 Bit               | 8 Bit                 | 8 Bit                 |

Reg. Adr.: Register address.

Preset Data: Register data.

### Function 08 Diagnostics

Used is only the Diagnostics function "Return Query Data" (Code 00). This allows to test the Modbus. The addressed slave returns the query without execution. The function is called up with the subfunction 00.

Query:

Data

| <i>Subfunction Hi</i> | <i>Subfunction Lo</i> | <i>Data Hi</i> | <i>Data Lo</i> |
|-----------------------|-----------------------|----------------|----------------|
| 8 Bit                 | 8 Bit                 | 8 Bit          | 8 Bit          |

Subfunction: Call of diagnostic function.

Data: Data.

Response:

Data

| <i>Subfunction Hi</i> | <i>Subfunction Lo</i> | <i>Data Hi</i> | <i>Data Lo</i> |
|-----------------------|-----------------------|----------------|----------------|
| 8 Bit                 | 8 Bit                 | 8 Bit          | 8 Bit          |

Subfunction: Call of diagnostic function.

Data: Data.

## Function 16 Preset Multiple Registers

Writes data into multiple registers of a slave. The number and the starting address of the registers are free. However the number of bytes is limited to 20 (address, function, data and CRC check).

Query:

Data

| Start Adr. Hi | Start Adr. Lo | No. of Register Hi | No of Register Lo | Byte Count | Data1 | ..... | Data N |
|---------------|---------------|--------------------|-------------------|------------|-------|-------|--------|
| 8 Bit         | 8 Bit         | 8 Bit              | 8 Bit             | 8 Bit      | 8 Bit | 8 Bit | 8 Bit  |

Start Adr.: Starting address of registers.

No. of Register: Number of registers to be written in.

Byte Count: Number of bytes to be transmitted.

Data N: Register data.

### Note

The number of bytes to be transmitted is limited to 20 because of the limited storage capacity of the RAM.

Response:

Data

| Start Adr. Hi | Start Adr. Lo | No. of Register Hi | No of Register Lo |
|---------------|---------------|--------------------|-------------------|
| 8 Bit         | 8 Bit         | 8 Bit              | 8 Bit             |

Start Adr.: Starting address of registers.

No. of Register: Number of registers to be written in.

### END

A message is terminated with a pause of min. 3.5 Character times = ca. 4ms.

## Parameter

Measured value and setpoint of the mass flow meter or controller are available either as analog signals or directly in engineering units as digital signals. The full functionality is only available in the digital mode.

The following parameters describe the functions accessible by the customer. A series of other parameters are only accessible by the manufacturer.

The following example shows the structure of a parameter:

| <b><i>Parameter name</i></b>             | Register address | <i>Write</i> | <i>Authorisation</i> |
|--|------------------|--------------|----------------------|
|  |                  | <i>Read</i>  | <i>Authorisation</i> |
| Description of the parameters            |                  |              |                      |
| Format / interpretation of the parameter |                  |              |                      |

The following parameter table lists the Modbus registers. In the detailed description you find the register addresses in HEX.

### Number types of the different parameters

| Type   | Value           | Description   |
|--------|-----------------|---|
| uint4  | 0...7           | unsigned integer 4 bits   |
| uint8  | 0...255         | unsigned integer 8 bits   |
| uint16 | 0...65536       | unsigned integer 16 bits: Often used to define two 8-bit values |
| uint32 | 0...429496729   | unsigned integer 32 bits  |
| int16  | -32768...+32767 | signed integer 16 bits  |

## Parameter table

| Name                        | Description  | EPROM register |
|-----------------------------|--|----------------|
| Gas flow                    | Measured value   | 0x0000..0x0001 |
| Temperature                 | Measured value   | 0x0002..0x0003 |
| Totaliser                   | Total gas flown  | 0x0004..0x0005 |
| Setpoint gas flow           | Control setpoint of gas flow   | 0x0006..0x0007 |
| Measured value analog input | Measured value of analog input port                                    | 0x0008..0x0009 |
| Valve control signal        | Actual value of the valve control signal                               | 0x000a..0x000b |
| Alarm                       | Alarm status   | 0x000c         |
| Hardware error              | Indicator for possible malfunction                                     | 0x000d         |
| Control function            | Selection of the controller mode                                       | 0x000e         |
| Instrument address          | Sets the Modbus instrument address                                     | 0x0013         |
| Measuring range             | Calibrated measuring range of the instrument                           | 0x0014..0x0015 |
| Unit of measured value      | Engineering unit of measured value                                     | 0x0016..0x0019 |
| Name of fluid               | Name of the measured gas   | 0x001a..0x001d |
| Serial number hardware      | Serial number of the electronic module                                 | 0x001e..0x001f |
| Version number hardware     | Development stage of the electronic module                             | 0x0020         |
| Version number software     | Development stage of the software                                      | 0x0021         |
| EPROM actualisation         | Stores the settings in the non-volatile memory                         | 0x0022         |
| Instrument name             | Name of the instrument   | 0x0023..0x0026 |
| Analog output manual        | Manual setting of the analog output                                    | 0x0028..0x0029 |
| Scanning speed S            | PWM scanning speed non linear/linear range                             | 0x002d         |
| Gain factor $K_p$           | Control parameter gain   | 0x002e..0x002f |
| Time constant $T_i$         | Control parameter integral time  | 0x0030..0x0031 |
| Feed forward F              | Control parameter feed forward   | 0x0032         |
| Non linearity N             | Control parameter valve offset compensation                            | 0x0033         |
| Soft reset                  | Resets all parameters to the power-on status                           | 0x0034         |
| Set of control parameters   | Selection of predefined control parameters                             | 0x0035         |
| Power-up alarm              | Activation of the power-up alarm function                              | 0x4040         |
| Power-up alarm setpoint     | Setpoint of power-up alarm   | 0x4041..0x4042 |
| Totaliser function          | Function of the totaliser  | 0x4043         |
| Totaliser scaling factor    | Scaling factor of the totaliser  | 0x4046..0x4047 |
| Totaliser unit              | Engineering unit of the total  | 0x4048..0x404b |
| Zero point suppression      | Zero point suppression   | 0x404c..0x404d |
| Reset hardware error        | Reset of the status hardware error                                     | 0x404f         |
| Automatic storage EPROM     | Storage mode of the non-volatile memory                                | 0x4050         |
| Backflow detection          | Indicates a negative flow  | 0x4052..0x4053 |
| Signal type analog output   | Signal type of the analog measured value output                        | 0x4084         |
| Signal type setpoint        | Signal type of the analog setpoint input                               | 0x4085         |
| Delay hardware error        | Delay time for the plausibility check<br>at a hardware error           | 0x4087         |
| Implemented functions       | Implemented functions (options)<br>according to the type of instrument | 0x4128..0x4129 |
| Calibration data set        | Selection of the calibration data set                                  | 0x4139         |

## Detailed explanation of parameters

|  |                     |       |              |
|--|---------------------|-------|--------------|
| <b>Measured value gas flow</b>   | 0x0000 . . . 0x0001 | Write | Not possible |
|  |                     | Read  | User         |
| Measured value of the gas flow in mln/min. Scaling according to customer specification, adjustable by manufacturer or sales partner. |                     |       |              |
| Value <i>float32</i>   |                     |       |              |

|  |                     |       |              |
|--|---------------------|-------|--------------|
| <b>Measured value temperature</b>            | 0x0002 . . . 0x0003 | Write | Not possible |
|  |                     | Read  | User         |
| Measured value of the gas temperature in °C. |                     |       |              |
| Value <i>float32</i>                         |                     |       |              |

|   |   |       |      |
|---|---|-------|------|
| <b>Totaliser</b>  | 0x004 . . . 0x0005  | Write | User |
|   |   | Read  | User |
| Total gas flow since last reset. Internally totalised in [mln] , may be scaled with an appropriate scaling factor according to the following formula: |   |       |      |
| $M_{Gas} = F_{Scalingfactor} * M_{Gas\_mln}$  |   |       |      |
| <b>Legend</b>   |   |       |      |
| M <sub>Gas</sub> :  | Total quantity of gas converted by the scaling factor                             |       |      |
| F <sub>Scalingfactor</sub> :  | Scaling factor (Definition according to register Scaling factor of the totaliser) |       |      |
| M <sub>Gas_min</sub> :  | Total quantity of gas in [mln]  |       |      |
| Any value can be written in this register (including negative values). The totaliser then starts from this value.                                     |   |       |      |
| Value <b>float32</b>  |   |       |      |
| The gas total may have any unit if properly scaled.   |   |       |      |
| Preset value: 0 mln. With a scaling factor of 1.0 the unit of the gas total is mln.   |   |       |      |

|  |                   |       |      |
|--|-------------------|-------|------|
| <b>Setpoint of gas flow</b>  | 0x0006 . . 0x0007 | Write | User |
|  |                   | Read  | User |
| Setpoint of the controller in mln/min.<br>To activate the setpoint, the controller mode (register 0x000e) has to be in mode 0 (automatic) or in mode 1 (Modbus).<br>The controller operates only with this setpoint if the power-up alarm (register 0x4040) is not active.<br>In this case the value is stored in the non-volatile memory and is still present after a power loss.<br>With the power-up alarm activated the setpoint will be lost at a power loss. |                   |       |      |
| Value <b>float32</b>   |                   |       |      |

|  |                   |       |              |
|--|-------------------|-------|--------------|
| <b>Measured value analog input</b>   | 0x0008 . . 0x0009 | Write | Not possible |
|  |                   | Read  | User         |
| Analog setpoint input for the controller. Manufacturer configuration as voltage [V] or current [mA]. The converted input value is always loaded into the register, whether the controller works in analog or digital mode. |                   |       |              |
| Value <b>float32</b> Value float32 voltage or current signal   |                   |       |              |

|  |                |       |      |
|--|----------------|-------|------|
| <b>Valve control signal</b>  | 0x000a..0x000b | Write | User |
|  |                | Read  | User |
| <p>Contains the actual control value for the valve whether the control value is generated from the controller (automatic mode) or manually set via Modbus.</p> <p>If the register control mode (0x000e) is defined as mode 10 the control value is immediately loaded into the register. In any other modes the value is stored in a buffer and becomes active when control mode 10 has been activated.</p> <p>It is possible to adjust directly the position of the control valve. If the value is outside of the normal range the error message <b>Data Out Of Range</b> is generated.</p> |                |       |      |
| Value <b>float32</b> valve control signal in percent [0...100%]  |                |       |      |

|   |   |       |              |
|---|---|-------|--------------|
| <b>Alarm messages</b>   | 0x000c  | Write | Not possible |
|   |   | Read  | User         |
| Indicates the alarm messages in a bit map. The bit pattern depends on the status of the instrument and the detected alarms. If an alarm condition is no longer valid the corresponding bit is automatically erased. |   |       |              |
| Value <b>uint16</b> (bits 15...0)   |   |       |              |
| Bit #   | Description   |       |              |
| Bit 0   | Indicates a negative flow ( flow value < 0 )  |       |              |
| Bit 1   | Indicates a negative flow exceeding the backflow setpoint.<br>The bit remains set until a positive flow is detected.            |       |              |
| Bit 2..14   | Not used  |       |              |
| Bit 15  | Hardware error<br>Indicates a hardware error (register 0x000d).<br>This bit is therefore an OR-function of all hardware errors. |       |              |

|                       |        |       |              |
|-----------------------|--------|-------|--------------|
| <b>Hardware error</b> | 0x000d | Write | Not possible |
|                       |        | Read  | User         |

Indicates eventual malfunctions during operation of the instrument. This Information persists even the problem has been solved and has to be reset with the parameter (Reset hardware error).

All alarm messages are reset if the instrument is switched off and activated again at power on if an alarm persists.

Value **uint16** (bits 15...0)

The following table explains the individual error bits

| Bit # | Description   |
|-------|---|
| 0     | <b>Power-up alarm</b><br>If the instrument is switched off with activated Power-up alarm and switched on again, then the active setpoint will be the readjusted power-up setpoint.<br>(see parameter power-up alarm setpoint).<br>This status will only be checked at power-up.                             |
| 1     | <b>Alarm analog setpoint</b><br>Raised if the analog setpoint is outside the valid range.<br>This alarm is only active if the instrument is a flow controller.  |
| 2     | <b>Zero point or leakage alarm</b><br>Raised If at a valve control signal of 0% (Valve electrically closed) a flow is measured. Possible causes are: An incompletely closed valve, internal leakage or a zero drift.<br>This alarm is only active if the instrument is a flow controller.                   |
| 3     | <b>No gas / jammed valve alarm</b><br>Raised if at a valve control signal of 100% (valve electrically fully open) no gas flow is measured.<br>This alarm is only active if the instrument is a flow controller.   |
| 4     | <b>No reaction</b><br>Raised if the valve control signal is raised or lowered and no variation of the gas flow is measured. Possible causes are: Jammed valve, changed pressure conditions or valve too small (after a change of gas).<br>This alarm is only active if the instrument is a flow controller. |
| 5     | <b>Sensor communication error</b><br>Raised if a communication problem occurs between the sensor and the electronic module. In this case the measurements are probably wrong.   |
| 6     | <b>RAM check</b><br>Raised if the cyclic RAM check fails.<br>Possible cause: Defective memory.  |
| 7     | <b>E<sup>2</sup>PROM access check</b><br>Raised if access errors to the E <sup>2</sup> PROM are detected.<br>In this case the correct function of the instrument is no longer guaranteed.   |
| 8     | <b>Totaliser memory corrupted</b><br>Raised if the storage of the total value is no longer possible.<br>In this case the totaliser always starts from 0 at power-on.  |
| 9     | <b>Invalid contents in E<sup>2</sup>PROM or empty E<sup>2</sup>PROM</b>   |
| 10    | <b>Current input overload ( &gt;25mA )</b>  |



|                        |        |       |      |
|------------------------|--------|-------|------|
| <b>Controller Mode</b> | 0x000e | Write | User |
|                        |        | Read  | User |

Selection of the controller mode and the source of the setpoint.

Value **uint16**

Attempting to write another value results in the error message **Data Out Of Range**.

The following options are possible:

| Value | Description   |
|-------|---|
| 0     | <b>Automatic setpoint selection</b><br>The source of setpoint is automatically selected, i.e.:<br>As standard the analog setpoint (voltage or current signal) is active.<br>If a digital setpoint is sent (via Modbus) automatically the DB05 switches to 'Digital mode' and the analog setpoint is disabled. |
| 1     | <b>Digital setpoint</b><br>Activates the digital setpoint via Modbus.   |
| 2     | <b>Analog setpoint (standard setting)</b><br>Selects the analog signal as setpoint source.  |
| 10    | <b>Direct adjustment of the valve signal</b><br>Deactivates the automatic control mode.<br>Sets the valve control to the value of register 'valve control signal'.<br>(0x000a . . 0x000b)   |
| 20    | <b>Setpoint 0%</b><br>Sets the setpoint to 0%.<br>The serial communication is ready for a new digital setpoint.   |
| 21    | <b>Setpoint 100%</b><br>Sets the setpoint to 100%.<br>The serial communication is ready for a new digital setpoint.   |
| 22    | <b>Valve fully closed</b><br>Deactivates the automatic control mode.<br>Sets the valve control to 0% (Valve fully closed).  |
| 23    | <b>Valve fully open</b><br>Deactivates the automatic control mode.<br>Sets the valve control signal to 100% (Valve fully open).   |
| 30    | <b>Test mode analog output</b><br>Deactivates the automatic control mode and sets the valve control to 0%.<br>Forces the analog output signal to the value in the register 'Analog output manual' (0x0028).   |
| 31    | <b>Test mode for the DAC of the current output</b>  |

|                           |        |       |      |
|---------------------------|--------|-------|------|
| <b>Instrument address</b> | 0x0013 | Write | User |
|                           |        | Read  | User |

Defines the instrument address with which the instrument can be addressed within a modbus structure. Up to 247 different addresses can be assigned in a modbus system.

**Attention**

In a system, in which several instruments are connected with each other via modbus, all instruments must have different addresses. Otherwise communication errors occur and the system will no longer function.

Value **uint16** consist of two uint8  
**uint8 (bits15..8)** are not used (should always be 0)  
**uint8 (bits7..0)** value of the instrument address  
Admissible values: 1..247  
Default: 247  
The error **data out of range** is generated when trying to define values outside of the admissible range.

|   |                |       |              |
|---|----------------|-------|--------------|
| <b>Measuring range</b>  | 0x0014..0x0015 | Write | Not possible |
|   |                | Read  | User         |
| Range of the measurable mass flow in mln/min for which the instrument was calibrated. |                |       |              |
| Value <b>float32</b> range of the measurable mass flow                                |                |       |              |

|  |                |       |              |
|--|----------------|-------|--------------|
| <b>Unit measuring value</b>  | 0x0016..0x0019 | Write | Not possible |
|  |                | Read  | User         |
| Name of the measuring medium in plain text.  |                |       |              |
| Value <b>uint16 x 4</b> whereby each uint16 consists of two uint8 == char8<br>Default value 0\ (zero) for all characters<br>0x0016 contains the first two characters, 0x0019 contains the last two characters. All four registers can be read independently of each other. |                |       |              |

|  |                |       |              |
|--|----------------|-------|--------------|
| <b>Name of medium</b>  | 0x001a..0x001d | Write | Not possible |
|  |                | Read  | User         |
| Name of the measuring medium in plain text.  |                |       |              |
| Value <b>uint16 x 4</b> whereby each uint16 consists of two uint8 == char8<br>Default value 0\ (zero) for all characters<br>0x001a contains the first two characters, 0x001d contains the last two characters. All four registers can be read independently of each other. |                |       |              |

|  |                |       |              |
|--|----------------|-------|--------------|
| <b>Serial number hardware</b>  | 0x001e..0x001f | Write | Not possible |
|  |                | Read  | User         |
| Clear and unique serial number of the electronic part of the measuring instrument (print). |                |       |              |
| Value <b>uint32</b><br>Possible range 0..(2 x 10 <sup>32</sup> -1)                         |                |       |              |

|  |        |       |              |
|--|--------|-------|--------------|
| <b>Version number hardware</b>   | 0x0020 | Write | Not possible |
|  |        | Read  | User         |
| Different development stages of the print are documented with unequivocal version numbers. |        |       |              |
| Value <b><i>uint16</i></b>   |        |       |              |

|   |        |       |              |
|---|--------|-------|--------------|
| <b>Version number software</b>  | 0x0021 | Write | Not possible |
|   |        | Read  | User         |
| Different development stages of the software are documented with unequivocal version numbers. |        |       |              |
| Value <b>uint16</b>   |        |       |              |

|   |   |       |      |
|---|---|-------|------|
| <b>E<sup>2</sup>PROM actualisation</b>  | 0x0022  | Write | User |
|   |   | Read  | User |
| <p>All settings made via modbus are saved to a volatile memory (RAM). If automatic save (Register 0x4050 storage mode of the non-volatile memory) is activated, the settings are saved immediately when written, also in the non-volatile memory (E<sup>2</sup>PROM).</p> <p>There are two different types of settings / parameters:</p> <ol style="list-style-type: none"><li>1. <i>Settings, which are only saved as long as the instrument runs (connected to the supply). When next turning the instrument on/off, the default values are activated again. These settings are saved in the volatile memory.</i></li><li>2. <i>Settings, which are also saved in case of an interruption of operations. These settings are saved in the non-volatile memory E<sup>2</sup>PROM</i></li></ol> <p>This command permanently saves all settings of all parameters of the second kind in E<sup>2</sup>PROM. If automatic save (register 0x4050 storage mode of the non-volatile memory) is deactivated, this is the only possibility to permanently save the settings to be stored in E<sup>2</sup>PROM.</p> |   |       |      |
| <b>Value <i>uint16</i></b>  |   |       |      |
| <i>Value</i>  | <i>Description</i>  |       |      |
| 0   | <i>Save settings</i><br>Writes the settings from the volatile to the non-volatile memory.                             |       |      |
| >0  | <i>Re-read settings</i><br>Reads the settings of the non-volatile memory and writes them back to the volatile memory. |       |      |

|   |                |       |              |
|---|----------------|-------|--------------|
| <b>Instrument name</b>  | 0x0023..0x0026 | Write | Not possible |
|   |                | Read  | User         |
| Name of the instrument type / instrument code.  |                |       |              |
| Value <b>uint16 x 4</b> whereby each uint16 consists of two uint8 == char8<br>Default value 0\ (zero) for all characters.<br>0x0023 contains the first two characters, 0x0026 contains the last two characters. All four registers can be read independently of each other. |                |       |              |

|   |                |       |      |
|---|----------------|-------|------|
| <b>Analog output manual</b>   | 0x0028..0x0029 | Write | User |
|   |                | Read  | User |
| <p>The analog power output is manually set to a certain current. The possible range is 0...21,6 mA. Smaller or larger values are clipped according to these limits.</p> <p>This function lets you check the connected evaluation of the of the analog measuring value. It is possible to write and read in this register at all times. The value set in this register is first output via the current interface upon activation (register control mode 0x000e =30).</p> <p>In order to return to the output of the current actual value via the analog current interface, the register (control mode 0x000e) must be reset accordingly.</p> |                |       |      |
| <p>Value <b>float32</b> current value in [mA]</p> <p>Default value 0 mA</p>   |                |       |      |

|  |        |       |      |
|--|--------|-------|------|
| <b>Scanning speed S</b>  | 0x002d | Write | User |
|  |        | Read  | User |
| <p>With a setpoint as of zero, the valve is accessed continuously and linear until a flow sets in. Afterwards, the instrument switches back to ‘normal control’.</p> <p>It is possible to change the speed of this continuous linear scanning process, which is proportional to the value set here.</p> <p>If a smaller value is set, the scanning process takes longer. On the other hand, the overshoot tendency is lesser with smaller setpoint defaults, vice versa with large values.</p> |        |       |      |
| <p>Value <b>uint16</b></p> <p><b>uint8</b> (bits 15...8) always zero</p> <p><b>uint8</b> (bits 7...0) admissible range [1 – 255]</p>   |        |       |      |

|  |                |       |      |
|--|----------------|-------|------|
| <b>Gain factor K<sub>P</sub></b>   | 0x002e..0x002f | Write | User |
|  |                | Read  | User |
| <p>Gain factor K<sub>P</sub> of the PI controller. The logic operation/function of this parameter is described further down in this manual. The following formula shows the meaning of K<sub>P</sub> in the PI controller:</p> $G(s) = \frac{K_P \times (sT_N + 1)}{sT_N}$ <p>A larger K<sub>P</sub> value makes the controller more exact, faster, more aggressive and more prone to oscillations. A smaller value makes it slower and less sensitive.</p> <p>The gain factor of the presently selected control parameter set is displayed.</p> |                |       |      |
| <p>Value <b>float32</b> gain factor K<sub>P</sub> without unit</p> <p>Default: 100</p> <p>The value must be positive. The error <b>Data Out Of Range</b> is generated when trying to define values outside of the admissible range.</p>  |                |       |      |

|   |                |              |             |
|---|----------------|--------------|-------------|
| <b>Time constant <math>T_N</math></b>   | 0x0030..0x0031 | <b>Write</b> | <b>User</b> |
|   |                | <b>Read</b>  | <b>User</b> |
| <p>Time constant <math>T_N</math> of the PI controller. The logic operation/function of this parameter is described further down in this manual. The following formula shows the meaning of <math>T_N</math> in the PI controller:</p> $G(s) = \frac{K_P \times (sT_N + 1)}{sT_N}$ <p>A smaller <math>T_N</math> value makes the controller more exact, faster, more aggressive and more prone to oscillations. A larger value makes it slower and less sensitive.</p> <p>The time constant of the presently selected control parameter set is displayed.</p> |                |              |             |
| <p>Value <b>float32</b> time constant <math>T_N</math> in seconds</p> <p>Default: 0,1 s</p> <p>The value must be larger than 0.0. The error <b>Data Out Of Range</b> is generated when trying to define values outside of the admissible range.</p>   |                |              |             |

|   |        |       |      |
|---|--------|-------|------|
| <b>Feed forward F</b>   | 0x0032 | Write | User |
|   |        | Read  | User |
| Feed forward share of a controller. The parameters are stated in 8 bit breakdown. The logic operation/function of this parameter is described further down in this chapter. |        |       |      |
| Value <b>uint16</b><br><b>uint8</b> (bits 15...8) always zero<br><b>uint8</b> (bits 7...0) F share of the currently selected controller                                     |        |       |      |

|  |        |       |      |
|--|--------|-------|------|
| <b>Non-linearity N</b>   | 0x0033 | Write | User |
|  |        | Read  | User |
| Offset compensation share (non-linear part N) of a controller. The parameters are stated with 8 bit breakdown. The logic operation/function of these parameters is described further down in this chapter. |        |       |      |
| <b>Remark</b><br>The N share is only active when the set setpoint is larger than zero.   |        |       |      |
| Value <b>uint16</b><br><b>uint8</b> (bits 15...8) always zero<br><b>uint8</b> (bits 7...0) N share of the currently selected controller  |        |       |      |

|  |        |       |              |
|--|--------|-------|--------------|
| <b>Soft reset</b>  | 0x0034 | Write | User         |
|  |        | Read  | Not possible |
| A software reset of the measuring or control instrument takes place if any chosen value is written in this register.<br>This returns the instrument to the state it had after its last activation. |        |       |              |
| <b>Attention</b><br>The soft reset is first performed after the response to this command was returned to the master.   |        |       |              |
| Value <b>uint16</b><br>Any value triggers reset  |        |       |              |

|   |  |       |      |           |      |   |                              |   |                              |   |                              |   |  |   |                              |         |                                      |
|---|--|-------|------|-----------|------|---|------------------------------|---|------------------------------|---|------------------------------|---|--|---|------------------------------|---------|--------------------------------------|
| <b>Selection of the control parameter set</b>   | 0x0035                                 | Write | User |           |      |   |                              |   |                              |   |                              |   |  |   |                              |         |                                      |
|   |  | Read  | User |           |      |   |                              |   |                              |   |                              |   |  |   |                              |         |                                      |
| The controller consists of altogether 5 complete control parameter sets (see the corresponding documentation). Three of these sets were defined by the manufacturer and cannot be changed by the user (so-called manufacturer control parameter sets). Two sets can be changed at wish by the user (so-called user control parameter sets).   |  |       |      |           |      |   |                              |   |                              |   |                              |   |  |   |                              |         |                                      |
| One set is used for the current control. This setting can be saved in E <sup>2</sup> PROM and is available again with the next activation. This set can be read, changed and re-written via modbus access. Afterwards, the controller immediately works with the modified set.  |  |       |      |           |      |   |                              |   |                              |   |                              |   |  |   |                              |         |                                      |
| <b>Function of the pre-defined control parameter sets:</b><br>Due to the flow end values, the correspondingly applied control valve and the pressure ratios, these sets receive different values for the parameters P, I, D, F and N. We will discuss the function of the individual parameters later on in this manual. The aim is to provide the controller with the following different properties with the three sets:      |  |       |      |           |      |   |                              |   |                              |   |                              |   |  |   |                              |         |                                      |
| U            Fast response time with the corresponding overshooting ( <b>fast response</b> )  |  |       |      |           |      |   |                              |   |                              |   |                              |   |  |   |                              |         |                                      |
| V            Medium response time with a low overshooting tendency.<br><b>(standard setting)</b>  |  |       |      |           |      |   |                              |   |                              |   |                              |   |  |   |                              |         |                                      |
| W            Slow response time without overshooting ( <b>slow response</b> )   |  |       |      |           |      |   |                              |   |                              |   |                              |   |  |   |                              |         |                                      |
| Value <b>uint16</b> consists of two uint8<br><b>uint8</b> (bit 15...8) selects the control parameter set for control and activates it.<br><i>The default set is the manufacturer control parameter set V.</i>   |  |       |      |           |      |   |                              |   |                              |   |                              |   |  |   |                              |         |                                      |
| <table><tr><td>Selection</td><td>Type</td></tr><tr><td>0</td><td>User control parameter set A</td></tr><tr><td>1</td><td>User control parameter set B</td></tr><tr><td>2</td><td>User control parameter set U</td></tr><tr><td>3</td><td>User control parameter set V (default)</td></tr><tr><td>4</td><td>User control parameter set W</td></tr><tr><td>5...255</td><td>not allowed: Data Out Of Range error</td></tr></table> |  |       |      | Selection | Type | 0 | User control parameter set A | 1 | User control parameter set B | 2 | User control parameter set U | 3 | User control parameter set V (default) | 4 | User control parameter set W | 5...255 | not allowed: Data Out Of Range error |
| Selection   | Type                                   |       |      |           |      |   |                              |   |                              |   |                              |   |  |   |                              |         |                                      |
| 0   | User control parameter set A           |       |      |           |      |   |                              |   |                              |   |                              |   |  |   |                              |         |                                      |
| 1   | User control parameter set B           |       |      |           |      |   |                              |   |                              |   |                              |   |  |   |                              |         |                                      |
| 2   | User control parameter set U           |       |      |           |      |   |                              |   |                              |   |                              |   |  |   |                              |         |                                      |
| 3   | User control parameter set V (default) |       |      |           |      |   |                              |   |                              |   |                              |   |  |   |                              |         |                                      |
| 4   | User control parameter set W           |       |      |           |      |   |                              |   |                              |   |                              |   |  |   |                              |         |                                      |
| 5...255   | not allowed: Data Out Of Range error   |       |      |           |      |   |                              |   |                              |   |                              |   |  |   |                              |         |                                      |

|   |                                |       |      |
|---|--------------------------------|-------|------|
| <b>Power-up alarm</b>   | 0x4040                         | Write | User |
|   |                                | Read  | User |
| <p>Activation of the power-up alarm function</p> <p>If the alarm is deactivated, the instrument behaves according to its standard or E<sup>2</sup>PROM settings after an operational disruption or reset.</p> <p>The following operations are performed in case of an operational disruption or reset if the power-up alarm is activated:</p> <ul style="list-style-type: none"><li>- The power-up alarm setpoint (register 0x4041 . . 0x4042) is used as the new setpoint. The last 'normal' setpoint is overwritten in this process.</li><li>- The power-up alarm bit is set to one in the register hardware error (0x000d).</li></ul> <p>However, these operations are only performed when the control mode (register 0x000e) is set to 1 (digital). Otherwise, only the alarm flag is set.</p> <p>In each case, the power-up alarm bit remains on 1 until it is explicitly deleted (see description 'Hardware errors').</p> |                                |       |      |
| Value <b><i>uint16</i></b>  |                                |       |      |
| <i>Value</i>  | <i>Description</i>             |       |      |
| 0   | Deactivates the power-up alarm |       |      |
| 1   | Activates the power-up alarm   |       |      |

|  |                   |       |      |
|--|-------------------|-------|------|
| <b>Power-up alarm setpoint</b>   | 0x4041 . . 0x4042 | Write | User |
|  |                   | Read  | User |
| Defines the setpoint, which is to be set automatically after an operational disruption or a reset of the instrument if the power-up alarm was configured accordingly.<br>If this value is changed and the instrument is already in power-up alarm mode, the changed alarm setpoint first becomes effective after the next operational disruption or reset. |                   |       |      |
| Value <b>float32</b> alarm setpoint in mln/min between 0 and end value.  |                   |       |      |

|  |        |   |      |
|--|--------|---|------|
| <b>Totaliser function</b>  | 0x4043 | Write   | User |
|  |        | Read  | User |
| Defines the totaliser function. This register is bit-coded.                              |        |   |      |
| Value <b>uint16</b> (bit15..0) whereby each bit stands for a certain totaliser function. |        |   |      |
| Bit  | Value  | Description   |      |
| 0  | 0      | Deactivates the totaliser function                              |      |
|  | 1      | Activates the totaliser function<br>If flow > zero, is totalled |      |
| 1..15  |        | No function   |      |

|  |                |       |              |
|--|----------------|-------|--------------|
| <b>Totaliser scaling factor</b>  | 0x4046..0x4047 | Write | Not possible |
|  |                | Read  | User         |
| <p>The read-out current integral is multiplied with this factor before the value is output via the modbus.</p> <p>This way it is possible to select any unit for the totaliser sum.</p> <p>In local mode, calculation takes place with mln/min. Multiplication with the following factor is required in order to read out the totaliser value in ls/min:</p> $F_{\text{Scaling factor}} = \frac{\Phi_{scm} \cdot 1}{1000} = 1 \cdot 10^{-3}$ |                |       |              |
| Value <b>float32</b>   |                |       |              |
| Default 1  |                |       |              |

|   |                |       |  |
|---|----------------|-------|--|
| <b>Totaliser unit</b>   | 0x4048..0x404b | Write |  |
|   |                | Read  |  |
| Engineering unit of the totalled totaliser value  |                |       |  |
| Value <b>uint16 x 4</b> whereby each uint16 consists of two uint8 == char8.<br>Default 0\ (zero) for all characters<br>0x4048 contains the first two characters, 0x404b contains the last two characters. All four registers can be read independent of each other. |                |       |  |

|  |                  |       |  |
|--|------------------|-------|--|
| <b>Zero point suppression</b>  | 0x0x404c..0x404d | Write |  |
|  |                  | Read  |  |
| <p>The mass flow measured in mln/min can be suppressed downwards with this register. If the mass value is smaller than the value set here, zero is output instead of the measuring value.</p> <p>This value must be larger than or equal zero. If a negative value is entered, a Data Out Of Range error is generated.</p> |                  |       |  |
| <p>Value <b>float32</b> unit mln/min</p> <p>Preset 0 sccm</p>  |                  |       |  |

|  |        |       |              |
|--|--------|-------|--------------|
| <b>Reset hardware error</b>  | 0x404f | Write | User         |
|  |        | Read  | Not possible |
| <p>Resets the alarm statuses of the instrument that occurred during operation. The meaning of the individual error bits are described in the register hardware errors (0x000d).</p> <p>Error bits cannot be set manually as they are always a consequence of faulty operating states. If you want to reset an error bit in the register hardware error (0x000d), the corresponding bit is set here in this register (0x404f). If a bit remains on zero, the error bit is also not changed.</p> |        |       |              |
| <p>Value <b>uint16</b> (bit15..0) whereby each bit stands for a specific error to be deleted</p> <p>Bit reset (to zero): the corresponding error bit is not modified</p> <p>Bit set (to one): the corresponding error bit is deleted</p>   |        |       |              |

|  |                            |       |      |
|--|----------------------------|-------|------|
| <b>Storage mode E<sup>2</sup>PROM</b>  | 0x4050                     | Write | User |
|  |                            | Read  | User |
| <p>Defines whether the registers that can be saved in E<sup>2</sup>PROM are automatically saved when writing or not.</p> <p>If this function is activated, the register is saved in the non-volatile memory with each change of the corresponding registers.</p> <p>If this function is not activated, changed register contents are only permanently saved if save take place explicitly with the command (register E<sup>2</sup>PROM actualisation).</p> |                            |       |      |
| Value <b><i>uint16</i></b>   |                            |       |      |
| <i>Value</i>   | <i>Description</i>         |       |      |
| 0  | No automatic saving        |       |      |
| 1  | Automatic saving activated |       |      |



|   |                |       |      |
|---|----------------|-------|------|
| <b>Backflow detection</b>   | 0x4052..0x4053 | Write | User |
|   |                | Read  | User |
| <p>Defines the limit in percent of the measuring range as of which a negative flow is detected by the sensor. If the negative flow exceeds this mark, the corresponding alarm flag is set (see ModReg: <i>alarm messages</i>) and the analog output is set to 10% of the respective maximum range (0.5 V with Vmax=5 V, 2 mA with Imax=20 mA).</p> <p>In order for the value set here to have an effect, the instrument function <i>backflow detection</i> must be previously set in the ModReg: <i>available instrument functions for users</i>. The value of this register can therefore also be written and read if this function was not activated.</p> <p>As the instrument cannot be calibrated for negative mass flows, it is not possible to detect negative flows. Only the sensor characteristics curve is reflected and the characteristics curve is assumed to be symmetric (which is of course not exactly the case).</p> <p>If invalid values are written in this register, a Data Out Of Range error is generated.</p> |                |       |      |
| <p><b>float32</b> the value is interpreted in percent [%] of the maximum flow value</p> <p>The admissible value range is [0, 20] %</p> <p>Default: 20</p>   |                |       |      |

|   |        |       |              |
|---|--------|-------|--------------|
| <b>Signal type analog measuring value</b> | 0x4084 | Write | Not possible |
|   |        | Read  | User         |

Defines the output value of the analog measuring value output.

Value **uint16**

The error message **Data Out Of Range** is generated when writing other values.

The following possible defaults are available:

| Value | Description                  |
|-------|------------------------------|
| 0     | 0...20 mA (0 – 5 V) linear   |
| 1     | 4...20 mA (1 – 5 V) linear   |
| 2     | 4...20 mA acc. to Namur NE43 |

|   |                              |       |              |
|---|------------------------------|-------|--------------|
| <b>Signal type analog setpoint</b>  | 0x4085                       | Write | Not possible |
|   |                              | Read  | User         |
| Sets the format of the analog setpoint input.   |                              |       |              |
| Value <b>uint16</b><br>The error message <b>Data Out Of Range</b> is generated when writing other values.<br>The following possible defaults are available: |                              |       |              |
| <i>Value</i>  | <i>Description</i>           |       |              |
| 0   | 0...20 mA (0 – 5 V) linear   |       |              |
| 1   | 4...20 mA (1 – 5 V) linear   |       |              |
| 2   | 4...20 mA acc. to Namur NE43 |       |              |



|                             |        |       |      |
|-----------------------------|--------|-------|------|
| <b>Delay hardware error</b> | 0x4087 | Write | User |
|                             |        | Read  | User |

Sets the minimum time in seconds during which a plausibility error has to occur constantly in operation before the corresponding error bit is set in the register hardware error (0x000d). If normal status returns before the end of this time, the time starts at t=0s again at the next occurrence of the same error.

The following errors are checked for their plausibility during operation:

- A flow larger than zero is measured despite a set value of 0%.
- No flow is measured despite a set value of 100%.
- Setpoint was increased, still flow does not increase.

These three errors correspond to the error bits 2..4 in the register hardware error. So if one of these errors persists longer than the defined time, the corresponding error bit is set.

Value **uint16** the value is interpreted in seconds

The admissible input range is: 0...600 seconds

If the value zero is set, the corresponding error bit is set as soon as an error occurs. The maximum delay is approx. 16 ms. Please note that different effects (inertia of the control valve, pressure build-up, etc.) cause an undesired error indication.

**Default:** 10 seconds

|   |                         |       |              |
|---|-------------------------|-------|--------------|
| <b>Implement functions</b>  | 0x4128..0x04129         | Write | Not possible |
|   |                         | Read  | User         |
| <p>The individual bits of these register represent different functions this instrument has. If a bit is set (1), the corresponding function is available, if the bit is deleted (0), the corresponding function is not available on this instrument.</p> <p>The functions visible here depend directly on the installed software version. If a new software version is installed, which offers additional / new functions, the corresponding bits are set here. With the registers <i>Available instrument functions for users</i>, you can block or release individual basically available functions for users.</p> <p>A <b>No Wrote Access error</b> is generated when attempting to write in these registers. These two registers can also be read / written individually (2 x uint16)</p> |                         |       |              |
| <b>uint 32</b> consisting of 32 bits <b>(bit 31...0)</b>  |                         |       |              |
| <i>Value</i>  | <i>Description</i>      |       |              |
| 0   | Controller is available |       |              |
| 1   | Totaliser is available  |       |              |
| 2   | Backflow detection      |       |              |

|                             |        |       |              |
|-----------------------------|--------|-------|--------------|
| <b>Calibration data set</b> | 0x4139 | Write | User         |
|                             |        | Read  | Not possible |

Up to three different calibration data sets can be saved in the instrument. These may have different pressures, end values or media.

Value ***uint16***  
Specifies, which data set is to be used:

| <i>Value</i> | <i>Description</i>             |
|--------------|--------------------------------|
| 1            | Internal data set (do not use) |
| 2            | Standard data set              |
| 3            | First optional data set        |
| 4            | Second optional data set       |

Values outside of 1...4 generate a ***Data Out Of Range*** error.

## Different Memories

The controller has three different memories respectively data sources:

- *E<sup>2</sup>PROM* (configuration data, etc.)
- *RAM* (measuring values, etc.)
- *ROM* (fixed-coded data in the program)

## Saving data in the non-volatile memory

Certain register contents are saved in the non-volatile memory (E<sup>2</sup>PROM). By setting the parameter *storage mode of the non-volatile memory*, you can define whether changes to these registers are saved immediately and automatically, or whether these are initially saved in RAM (volatile memory) first.

With the parameter 'update E<sup>2</sup>PROM', you save all registers, which can be deposited at all in the non-volatile memory, in E<sup>2</sup>PROM.

## Control characteristics

### Control circuit structure

The controller consists of a linear and a non-linear part. The linear part of the controller consist of the following components:

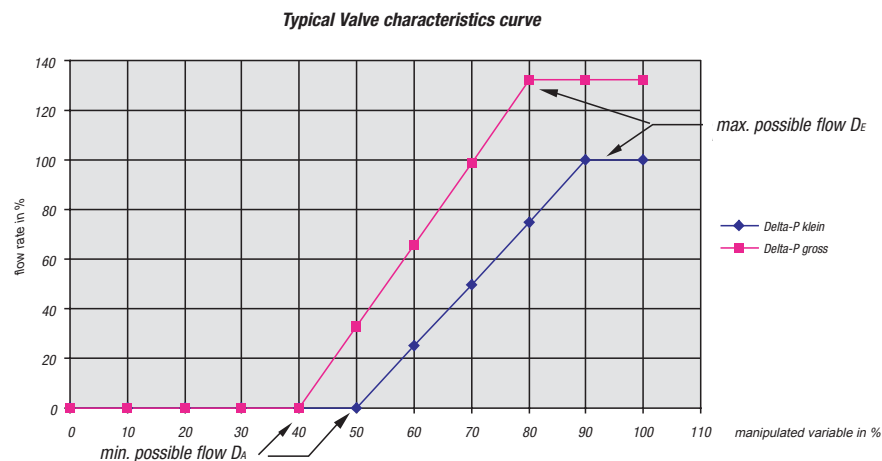
- Gain factor  $K_P$
- Time constant  $T_N$

The non-linear part consists of two components:

- Feed forward share  $F$
- Offset compensation share  $N$
- Scanning speed  $S$

### Valve characteristics curve

In its work range, the valve characteristics curve has almost linear characteristics. Here, the valve does not use the entire adjustment value range from 0% to 100%. The operating points  $D_A$  (minimum possible flow) and  $D_E$  (max. possible flow) depend on the inlet pressure and the pressure difference across the valve. As mentioned, the valve behaves linear in the work range. However, because  $D_A$  is not located at 0% adjustment value, the valve behaves non-linear when seen as a whole.



## Function of the individual parameters

### Non-linearity $N$

A linear controller (PI) only functions as intended when the distance to be controlled behaves approximately linear in the entire work section. As described above, this is not the case here.

The parameter *non-linearity  $N$*  compensates the dead zone in the area 0% to  $D_A$ %. This compensation only takes place with a setpoint default larger than zero.

With setpoint defaults larger than zero, a value generated by  $N$  is added to the controlling signal generated by the linear control algorithm. Naturally, the value  $N$  may never be larger or equal the value  $D_A$  in %. Different pressure ratios and temperature changes move the value  $D_A$ .

## Minimum scanning speed $S$

With a setpoint jump away from zero, the valve tension has to be increased with a certain speed after reaching the  $N$  value. This speed can be influenced with this parameter. The following correlation applies:

The larger the set value, the faster the valve reaches its actual opening point, which increases the likelihood of producing an overshoot with smallest setpoint defaults. Therefore, the value should represent an optimum between the setpoint step height and the opening speed.

## Feed forward share $F$

This share effects that the setpoint has a direct influence on the control value. It does not contribute to the control signal if the setpoint is zero. If the setpoint is larger than zero, this value is directly multiplied with the  $F$  share and the result is added to the control value.

If all remaining shares of the controller were set to zero and only the *feed forward share  $F$*  used, a direct control of the control valve results. The setpoint would simply control the valve in the range 0% – 100% opening.

Of course, the effect of  $F$  strongly depends on the pressure, as pressure changes also change the valve characteristics curve.

This way, one can largely realise a high control speed ( $F$  share) with a high control accuracy (slow  $PI$  share).

## Controller setting

We recommend setting the individual controller parameters according to the following procedure:

1. Non-linearity  $N$
2. Minimum scanning speed  $S$
3. Gain factor  $K_P$
4. Time constant  $T_N$
5. Feed forward share  $F$

### Setting the non-linearity $N$

1. Connect the controller electrically (warm-up time) and establish the operating conditions (pressure ratios) if possible.
2. With the software, you have access to the control parameter sets A and B
3. Set the control parameters to the following values:  $S = 0$ ;  $K_P = 0,001$ ;  $T_N = 0,02$ ;  $N = 0$
4. Set the setpoint to 5% of the final value.
5. Increase the parameter  $N$  in steps of 5 until a flow sets in.
6. Set  $N$  to 80% of the detected value.  $N$  remains identical for all sets.

### Setting the gain factor $K_P$

1. A setpoint jump from 0% to 50% is defaulted.
2.  $K_P$  is increased until the system becomes unstable with this setpoint jump. (non-abating constant oscillation with period  $T_{oscillation}$ )
3.  $K_P$  is now set to the following value:

|                          |                                       |
|--------------------------|---------------------------------------|
| <i>Optimised control</i> | $K_P = 150\%$ of the determined value |
| <i>Maximum speed</i>     | $K_P = 180\%$ of the determined value |
| <i>Maximum stability</i> | $K_P = 120\%$ of the determined value |

### Setting the time constant $T_N$

With the determined value for the oscillation period  $T_{oscillation}$ , the time constant  $T_N$  to be set can be calculated as follows:

|                          |                                   |
|--------------------------|-----------------------------------|
| <i>Optimised control</i> | $T_N = 1/12$ of $T_{oscillation}$ |
| <i>Maximum speed</i>     | $T_N = 1/15$ of $T_{oscillation}$ |
| <i>Maximum stability</i> | $T_N = 1/9$ of $T_{oscillation}$  |

### Setting the feed forward share $F$

We recommend leaving this parameter at zero.

### Setting the minimum scanning speed S

1. A setpoint jump from 0% to 5% is defaulted.
2. The minimum scanning speed is increased in steps of 5 until a slight overshoot sets in with the setpoint jump.
3. The detected value can be left for an optimum control speed. For maximum stability, the set value should amount to 70% of the detected value. The following table applies for maximum speed:

| Determined value in a range of | Value to be set              |
|--------------------------------|------------------------------|
| 0 ... 50                       | 200% of the determined value |
| 51 ... 100                     | 150% of the determined value |
| 101 ... 195                    | 130% of the determined value |
| > 195                          | 255                          |

### Backflow Detection

#### General

A function is implemented as of firmware version 3.1.5, which allows the detection of negative mass flows. This function is intended for measuring instruments and only makes little sense in control operation.

#### Function description

If this function is activated, the mass flow metre behaves as follows:

*Negative flows are detected and the corresponding alarm flags set (with and w/o hysteresis).*

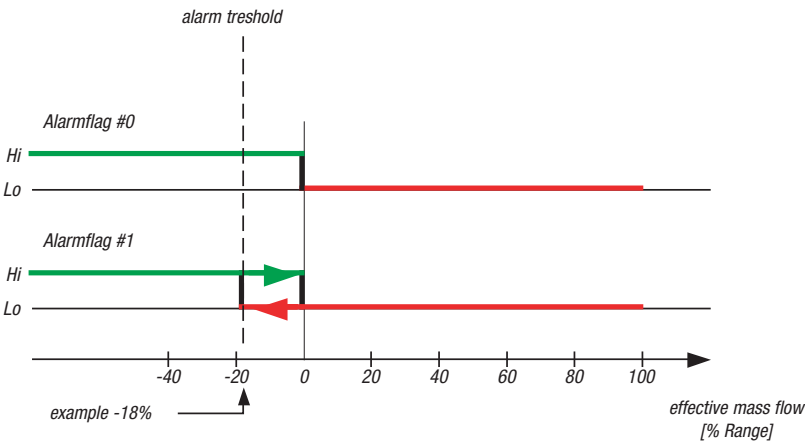
*Negative flows are detected and signalled with the analog signal output (with hysteresis).*

#### Setting the alarm threshold

With the ModReg: backflow detection, you can set an alarm threshold in the range from 0% to 20% of the maximum flow (see ModReg reference).

#### Digital signalling

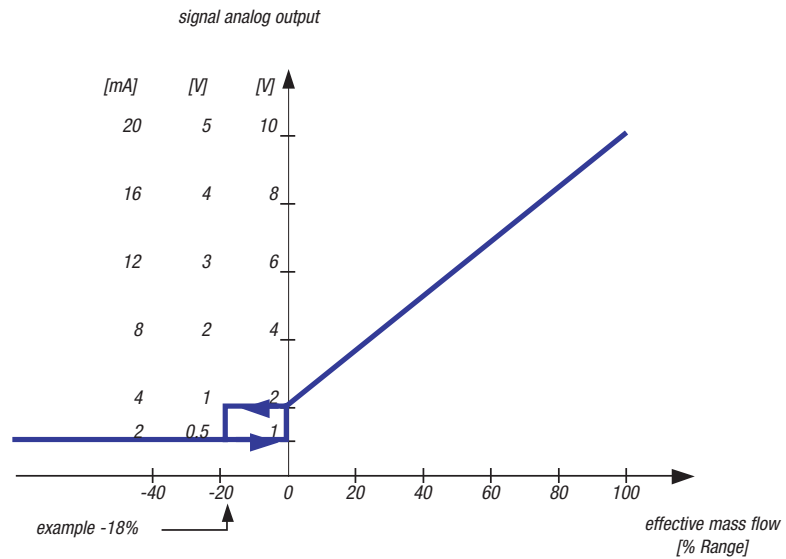
The alarm can be queried with the help of the ModReg: alarm messages. The register shows the current state of the negative mass flow with the two flags #0 and #1.



Here, the alarm threshold that can be adjusted by the user influences the hysteresis behaviour of the alarm flag #1.

## Analog signalling

The analog measuring value output is also influenced in addition to alarm flag #1. Signalling with the analog output signal is only possible if a suitable signal format was selected. Possible formats are 4..20 mA, 1..5 V, 2..10 V.



If the condition for setting alarm flag #1 is fulfilled, the analog output is set to half the value of the minimum output value.

## Accuracy

The accuracy of the backflow detection (switching threshold of alarm flag #1) directly depends on the symmetry of the sensor characteristics curve as well as the offset trimming.

The sensor is only calibrated for the positive flow range. This inevitably results in an inaccuracy for measuring in the negative range.

## 07 Software

*This software* is a configuration software that lets you control and change instrument parameter easily. In addition, you can check your interface cabling with *DB05*, map the bus structure and modify instrument addresses if required.

*The software* works on IBM-compatible computer systems with the operating

.

### **Installation**

After inserting the CD, you can select, which programs or manuals you want to install and/or open. With a manual installation, proceed as follows:

The enclosed CD contains a directory called '*red-y*'. Open this directory and start the program [setup.exe]. Menu guide you through the installation.

### **Functions**

*The software* provides the following function blocks

- *Configuration of the serial computer interface*
- *Setting the program language*
- *Scanning and mapping the bus structure*
- *Integrating individual instruments into the bus structure*
- *Reading out the instrument-specific hardware and software versions*
- *Displaying the measuring value, the totaliser and the temperature of a instrument*
- *Setting setpoint values*
- *Resetting the totaliser*
- *Selecting the control parameter sets*
- *Setting the PI control parameters and checking their function mode*
- *Selecting the corresponding calibration data record*
- *Optional data recording*

### **Direct help**

The functions within the program are described in the help menu.

## 08 Troubleshooting

In the following table, we have compiled possible error situations, their causes and possible remedies. If the error on your measuring or control instrument is not listed, please contact your distribution partner or return the instrument. Please observe the recommendations in the chapter 'Returns'.

If you need to open the pipe system due to the suggested measures, observe all required rinsing processes and the hazard potential of systems under pressure in general.

In the chapter 'Operation and Maintenance', you will find illustrated instructions about disassembling and cleaning the instruments. Observe the proper procedure.

| <i>Error</i>                         | <i>Possible cause</i>                         | <i>Measures</i>  |
|--------------------------------------|---|--|
| Output signal remains at 4 mA or 1 V | <i>No gas</i>                                 | Check: <ul style="list-style-type: none"> <li>- Is the gas supply working?</li> <li>- Are all shut-off valves open?</li> <li>- Are any filters clogged?</li> </ul>   |
|                                      | <i>Contamination</i>                          | Open the pipe system and check it for possible contamination.  |
| No output signal (0 mA or 0 V)       | <i>Electric supply</i>                        | Check: <ul style="list-style-type: none"> <li>- Is the supply connected and OK (+ 24 V DC)?</li> <li>- Are connection cables interrupted?</li> </ul> With present digital evaluation: <ul style="list-style-type: none"> <li>- Does the digital communication still work?</li> </ul>             |
|                                      | <i>Evaluation</i>                             | Make sure whether there is also no signal at the input of your evaluation.<br>Have you installed the shunt resistance (250 Ohm ) with 0 – 5 V layout for your evaluation?  |
|                                      | <i>Defect circuit board</i>                   | In case the digital evaluation still functions, the error description can be specified further for the necessary repair. Send in the instrument as described in chapter 5.   |
| Flow despite a setpoint of zero      | <i>Valve leaks</i>                            | The instrument or at least the valve is contaminated. Open the pipe system and check it for possible contamination. Contact your distribution partner. Either send in the instrument for repair or exchange the control valve cartridge.   |
|                                      | <i>Control circuit does not work properly</i> | Separate the connection cables from the instrument and open the casing cover. Then pull out the valve plug, replace the cover and reconnect the connection cable. If the actual value is zero now, check the control parameters. For control purposes, select one of the provided standard sets. |
|                                      | <i>Wrong control parameters</i>               | Check the parameter N and reduce this if required.   |

|   |   |   |
|---|---|---|
|   | <i>Defect circuit board</i>                   | Send in the instrument for repair as described in chapter 5.  |
|   | <i>Offset though installation position</i>    | A zero point offset may occur with vertical installation position and higher pressures.   |
| No flow despite a setpoint larger than zero | <i>No gas</i>                                 | Check: <ul style="list-style-type: none"> <li>- Is the gas supply working?</li> <li>- Are all shut-off valves open?</li> <li>- Are any filters clogged?</li> </ul>  |
|   | <i>Contamination</i>                          | Open the pipe system and check it for possible contamination.   |
|   | <i>Control circuit does not work properly</i> | Separate the connection cables from the instrument and open the casing cover. Check the correct position of the valve plug. Then reinstall the valve plug and reassemble the casing. If the actual value is zero now, check the control parameters. For control purposes, select one of the provided standard sets.       |
|   | <i>Control parameters</i>                     | Check the control parameters and use one of the provided standard sets for control purposes.  |
|   | <i>Defect circuit board</i>                   | Send in the instrument for repair as described in chapter 5.  |
| Actual value smaller than setpoint          | <i>Gas supply</i>                             | Check the gas supply. Does the pressure P1 specified on the type plate correspond to the actual one?<br>Did you observe the recommendations for dimensioning the pipe system?   |
|   | <i>Contamination</i>                          | Open the pipe system and check it for possible contaminations including the installed filters. If you detect contamination, check the instrument as well. If you think the valve is contaminated as well, contact your service representative. Send in the instrument for repair or obtain a new control valve cartridge. |
|   | <i>Control parameters</i>                     | Check the control parameters and use one of the provided standard sets for control purposes.  |
| Actual value unstable                       | <i>Gas supply</i>                             | Check the gas supply for constant pressure or any elements that destabilise the system. Did you observe the recommendations for dimensioning the pipe system?   |
|   | <i>Contamination</i>                          | Open the pipe system and check it for possible contaminations including the installed filters. If you detect contamination, check the instrument as well. If you think the valve is contaminated as well, contact your distribution partner.  |



|                                |   |   |
|--------------------------------|---|---|
| Control unstable               | <i>Gas supply</i>                       | <p>Check the gas supply for constant pressure or any elements that destabilise the system. Especially a too small dimensioned pressure reduction can produce very negative influences.</p> <p>With very small flows with an oversized gas supply, sporadic pressure changes (ON-OFF function pressure reduction) can also lead to unstable pressure characteristics.</p> <p>Did you observe the recommendations for dimensioning the pipe system?</p>   |
|                                | <i>Contamination</i>                    | <p>Open the pipe system and check it for possible contaminations including the installed filters. If you detect contamination, check the instrument as well. If you think the valve is contaminated as well, contact your service representative. Send in the instrument for repair or obtain a new control valve cartridge.</p>  |
|                                | <i>Setpoint default unstable</i>        | Check the setpoint default.   |
|                                | <i>Control parameters</i>               | Check the control parameters and use one of the provided standard sets for control purposes.  |
| Flow doesn't meet expectations | <i>Conversion factor not considered</i> | <p>Check the gas type specified on the type plate. If it does not correspond to the one that is actually used, you have to consider the corresponding conversion factor.</p> <p>You can check the programmed gas type with the software .</p>   |
|                                | <i>Contamination</i>                    | <p>Open the pipe system and check it for possible contaminations including the installed filters. If you detect contamination, check the instrument as well. In case of contamination in the flow division section, the displayed flow is higher than the actual one, vice versa when the measuring channel is contaminated.</p> <p>If you think the valve is contaminated as well, contact your service representative. Send in the instrument for repair or obtain a new control valve cartridge.</p> |
|                                | <i>Leak</i>                             | <p>Do not use any liquid leak detector liquids for determining leaks inside the instrument. Helium leak detectors or gas sniffers are ideal. If you suspect a leak inside the measuring instrument, contact your service representative or send in the instrument for repair.</p>   |

|   |  |   |
|---|--|---|
| Control parameters cannot be changed            | <i>No more communication</i>               | Check the communication.  |
|   | <i>Wrong parameter set</i>                 | Select the correct parameters sets.   |
| Substantial heat build-up on the control casing | <i>Setpoint default without gas supply</i> | Try to avoid this state over longer periods if possible. Your instrument might get damaged in the long run. |
|   | <i>Control parameters</i>                  | Check the control parameters and use one of the provided standard sets for control purposes.                |

## 09 Accessories

### Cables & Modules

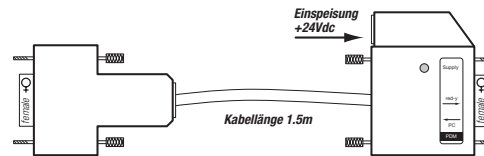
| Type       | Part Number  | Description / Length / Use   |
|------------|--|--|
| <b>PDM</b> | <b>328-2150</b>  | <b>Power Digital Module (1.5m)</b><br>Communication cable PC/DB05<br>(passive level converter RS232/RS485)                                   |
| <b>BAM</b> | <b>328-2151</b>  | <b>Bus Analog Module (0.1m)</b><br>Digital communication combined with pluggable screw terminals for analog signals                          |
| <b>PSM</b> | <b>328-2152</b>  | <b>Power Separator Module</b><br>Power module with power separator for additional power supply PSD   |
| <b>PAM</b> | <b>328-2153</b>  | <b>Power Analog Module</b><br>Operation with analog signals only<br>(pluggable screw terminals)<br>Powered by power supply PSD               |
| <b>BEC</b> | <b>328-2160 0.5m</b><br><b>328-2161 2.0m</b><br><b>328-2162 5.0m</b> | <b>Bus Extension Cable</b><br>Extension cable for digital communication and analog signals   |
| <b>BFC</b> | <b>328-2163</b>  | <b>Bus Feeder Cable (2.0m)</b><br>Junction cable PCU/DB05<br>Fixing screws on both sides   |
| <b>BTM</b> | <b>328-2139</b>  | <b>Bus Terminator Module</b><br>Termination resistor for bus communication   |
| <b>PAC</b> | <b>328-2164</b>  | <b>Power Analog Cable (3.0m)</b><br>Loose ends: For analog operation of the controller   |
| <b>PDC</b> | <b>328-2165</b>  | <b>Power Digital Cable (3.0m)</b><br>Loose ends: For analog and digital operation of meter or controller with external converter RS232/RS485 |
| <b>PSD</b> | <b>328-2231</b>  | <b>Power Supply Device, Euro-Version</b><br>Plug-type power supply 24V, 0.35A (8W)<br>Secondary side plug: dia. 2.1/5.5mm                    |
| <b>PSD</b> | <b>328-2232</b>  | <b>Power Supply Device, Euro-Version</b><br>Plug-type power supply 24V, 1.25A (30W)<br>Secondary side plug: dia. 2.1/5.5mm                   |

## Cables & Modules: Circuit Diagramm/Signal Flow

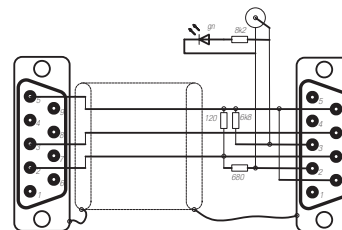
**PDM 328–2150**

### Power Digital Module (1.5m)

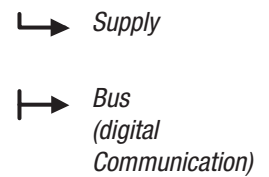
Communication cable PC/DB05  
(passive level converter RS232/RS485)  
Power Supply with PSD



### Circuit diagram



### Signal flow

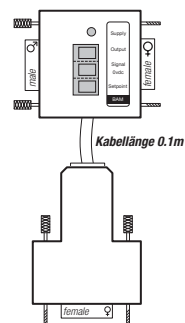


**BAM 328–2151**

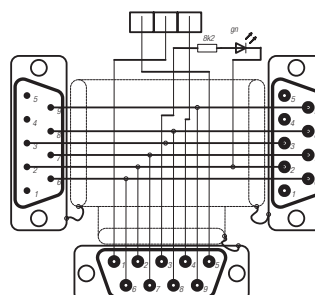
### Bus Analog Module (0.1m)

Digital communication combined with pluggable screw terminals for analog signals

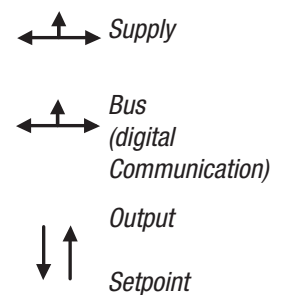
Pluggable screw Type Phoenix 3 MCVR 1,5/3-ST-3.81  
contact spacing 3.81mm, 3 pole  
max. cable cross section 1.5mm<sup>2</sup>



### Circuit diagram



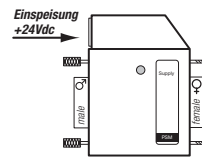
### Signal flow



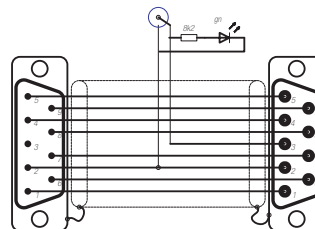
## PSM 328–2152

### Power Separator Module

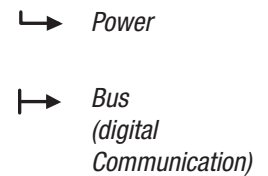
Power module with power separator for additional power supply PSD



#### Circuit diagram



#### Signal flow

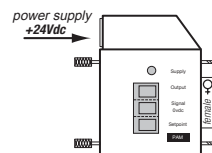


## PAM 328–2153

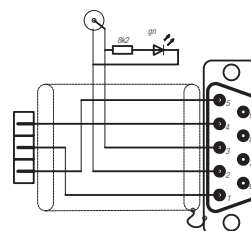
### Power Analog Module

Operation with analog signals only (pluggable screw terminals)  
Powered by power supply PSD

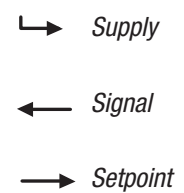
Pluggable screw Type Phoenix 3 MCVR 1,5/3-ST-3.81  
contact spacing 3.81mm, 3 pole  
max. cable cross section 1.5mm<sup>2</sup>



#### Circuit diagram



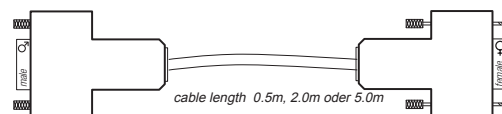
#### Signal flow



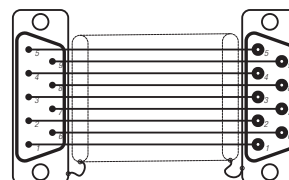
**BEC**    328-2160 0.5m  
           328-2161 2.0m  
           328-2162 5.0m

## Bus Extension Cable

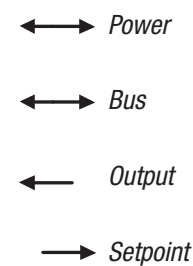
Extension cable for digital communication and analog signals



### Circuit diagram



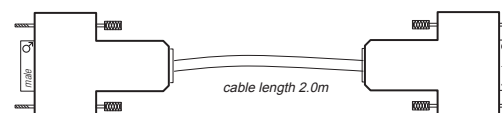
### Signal flow



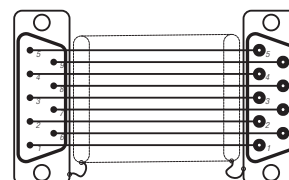
**BFC**    328-2163

## Bus Feeder Cable (2.0m)

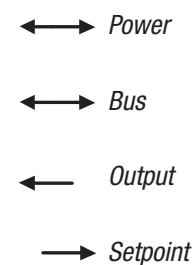
Junction cable PCU/DB05  
 Fixing screws on both sides



### Circuit diagram



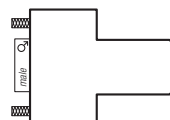
### Signal flow



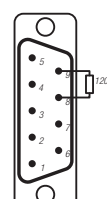
**BTM**    328-2139

## Bus Terminator Modul

Termination resistor for bus communication



### Circuit diagram



## PAC 328–2164

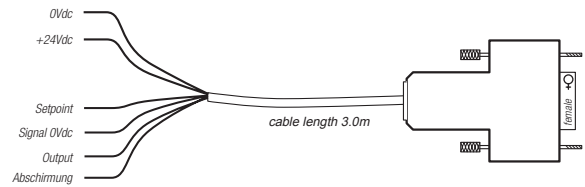
### Power Analog Cable (3.0m)

Plug-type power supply 24V, 0.35A (8W)

Secondary side plug: dia. 2.1/5.5mm

PVC-Cable, grey 3m, 5x0.25mm<sup>2</sup>, shielded

stripped wire 10cm



#### Sub D plug, 9 pole, female

|   |             |        |
|---|-------------|--------|
| 2 | 0Vdc        | brown  |
| 3 | +24Vdc      | white  |
| 1 | Signal 0Vdc | grey   |
| 4 | Output      | green  |
| 5 | Setpoint    | yellow |
|   | Screen      | violet |

## PDC 328–2165

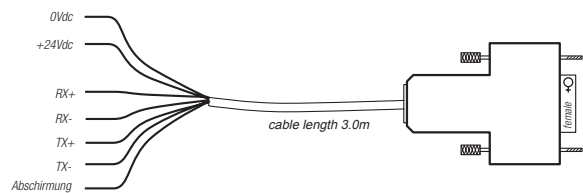
### Power Digital Cable (3.0m)

Plug-type power supply 24V, 1.25A (30W)

Secondary side plug: dia. 2.1/5.5mm

PVC-Cable, grey 3m, 6x0.25mm<sup>2</sup>, shielded

stripped wire 10cm



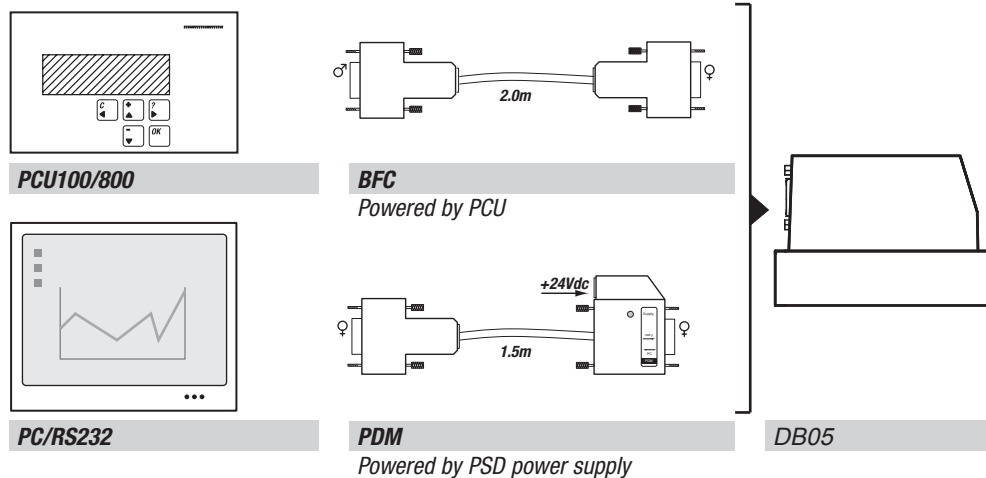
#### Comms. converter RS232/RS485

#### Sub D plug, 9 pole, female

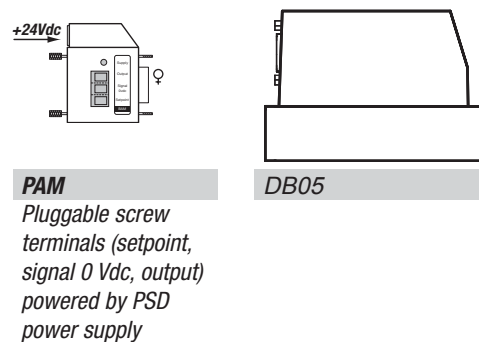
|   |        |        |
|---|--------|--------|
| 2 | 0Vdc   | brown  |
| 3 | +24Vdc | white  |
| 6 | Tx+    | green  |
| 7 | Tx-    | yellow |
| 8 | Rx-    | grey   |
| 9 | Rx+    | pink   |
|   | Screen | violet |

## Connection examples

### Connection of one meter or controller

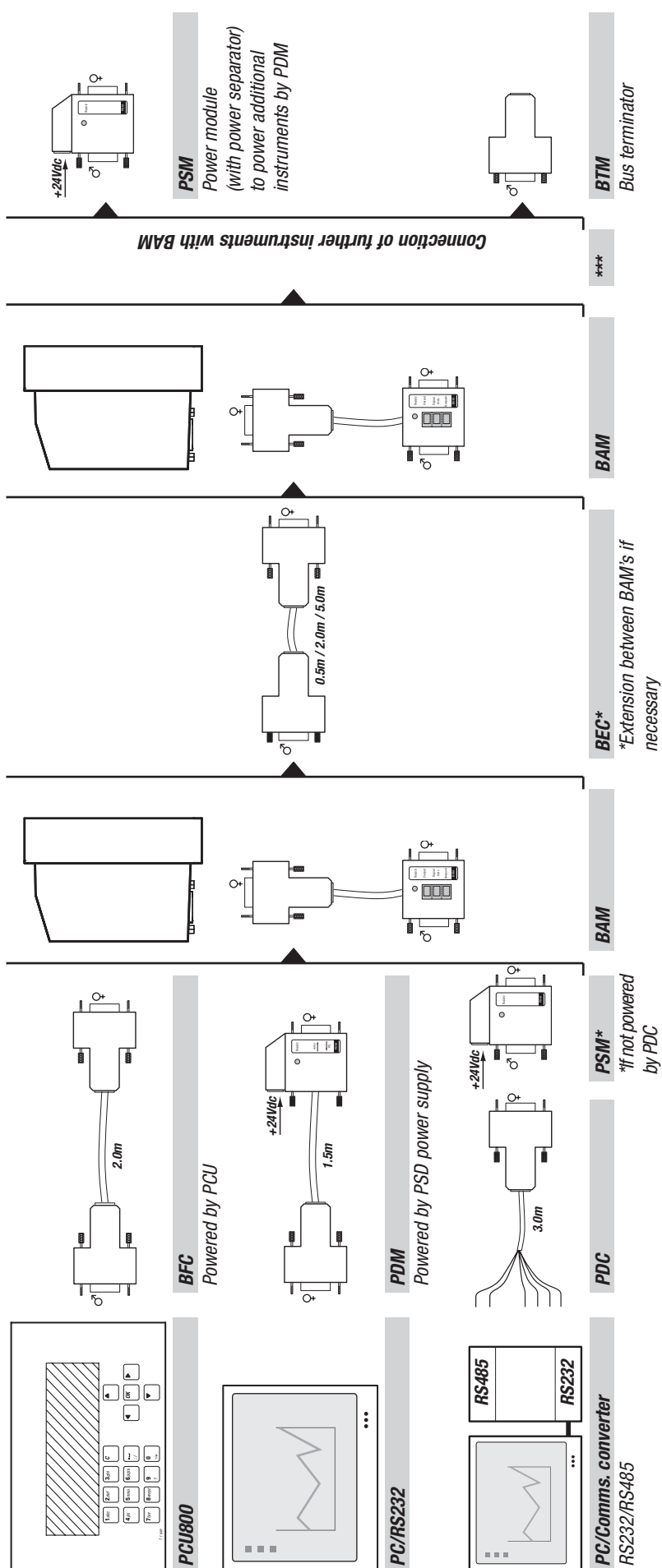


### Operation with analog signals



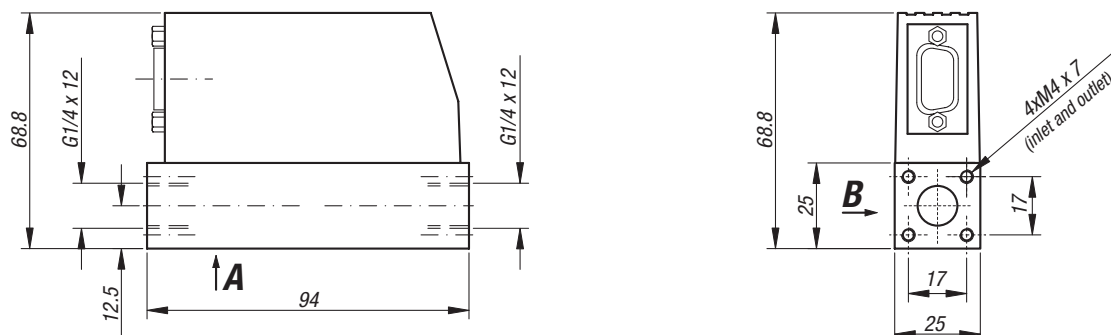


## Connection of multiple meters or controllers

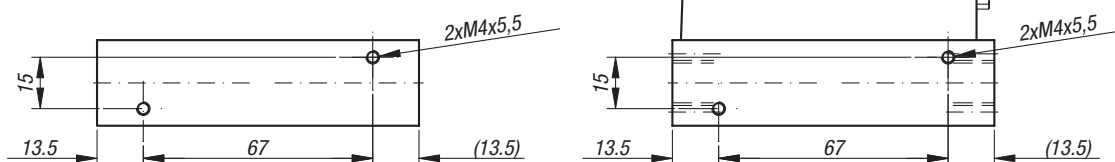


## 10 Dimensions

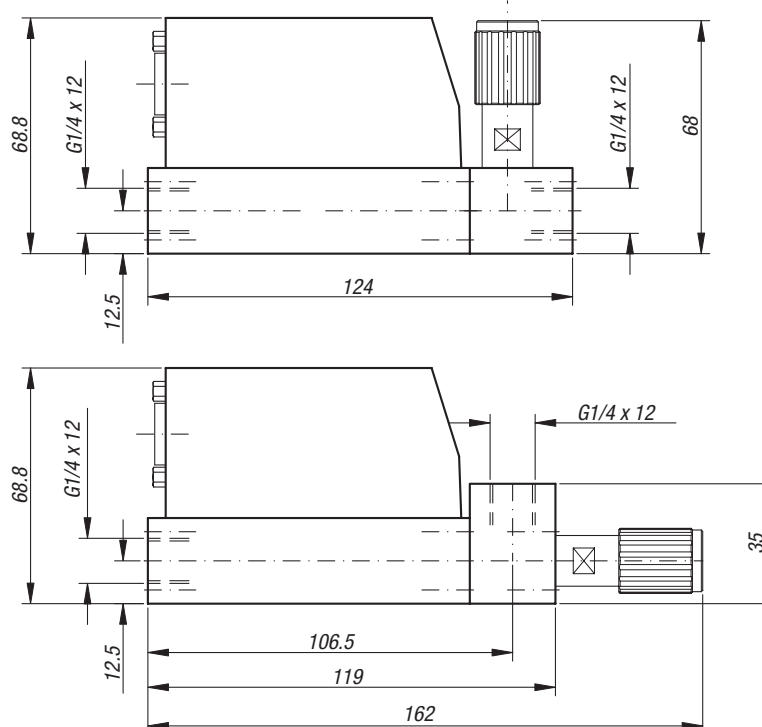
### Dimensions G1/4"



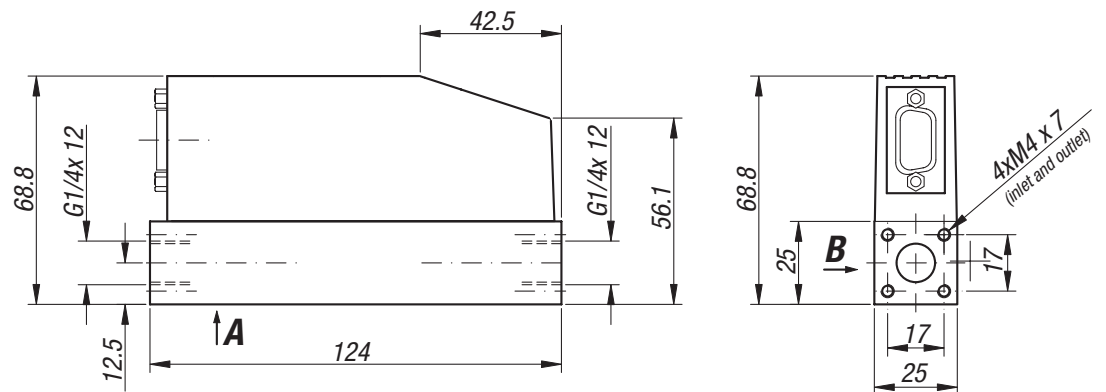
### Mounting / Fixation: Ansicht A / View A / Vue A



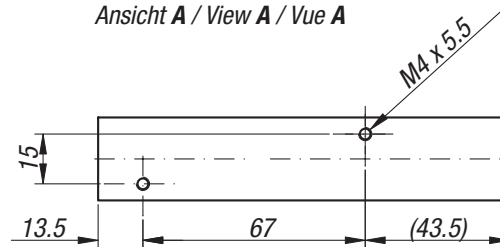
### With manual valve



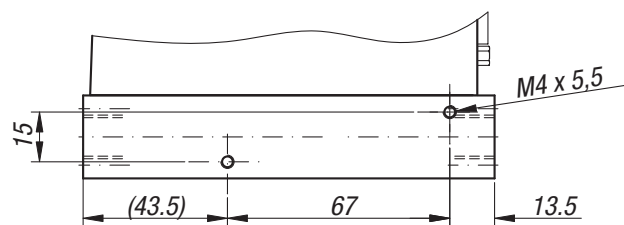
## Dimensions G1/4"



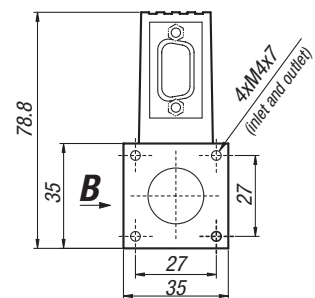
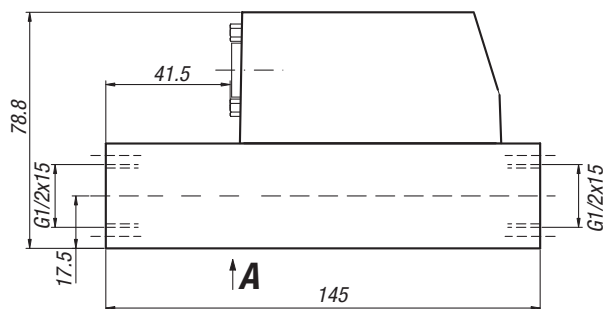
Ansicht A / View A / Vue A



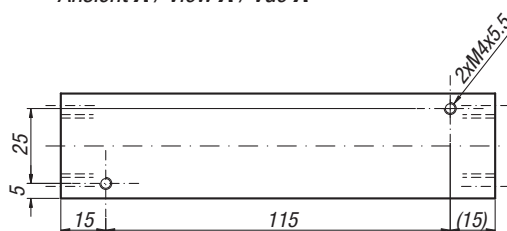
Ansicht B / View B / Vue B



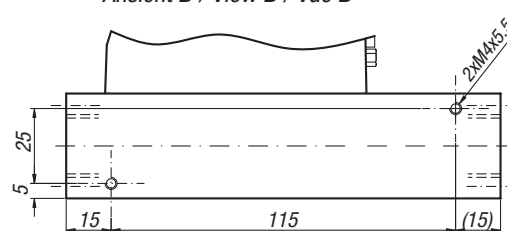
## Dimensions G1/2"



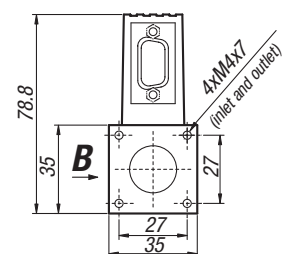
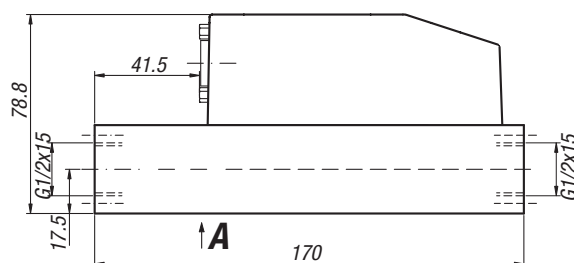
### Befestigung / Mounting / Fixation: Ansicht A / View A / Vue A



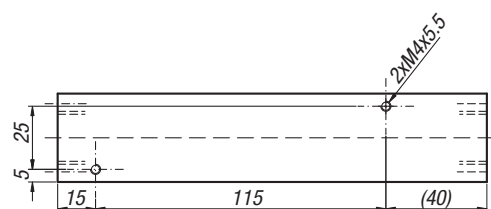
### Ansicht B / View B / Vue B



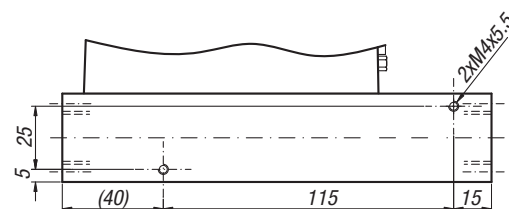
## Dimensions G1/2"



### Befestigung / Mounting / Fixation: Ansicht A / View A / Vue A

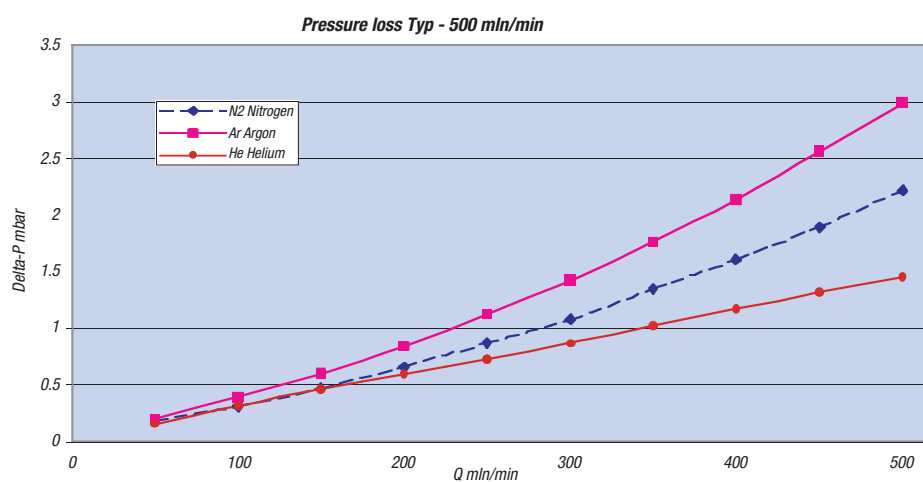
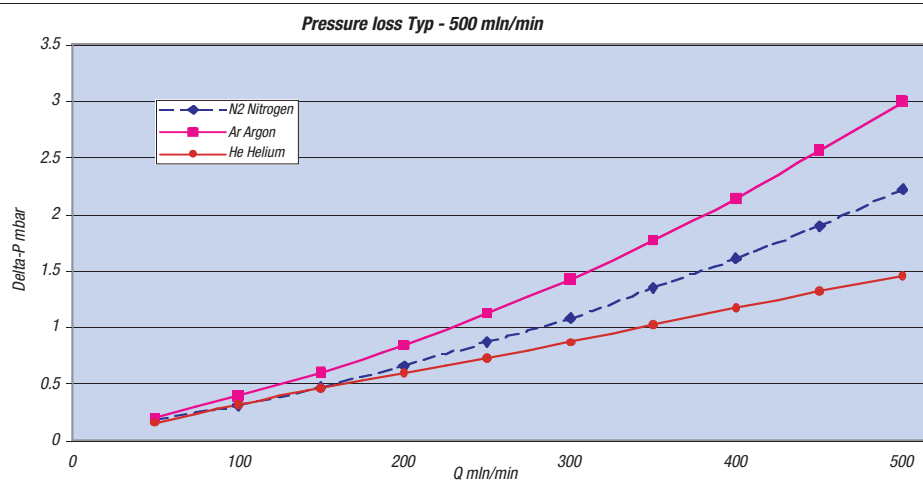
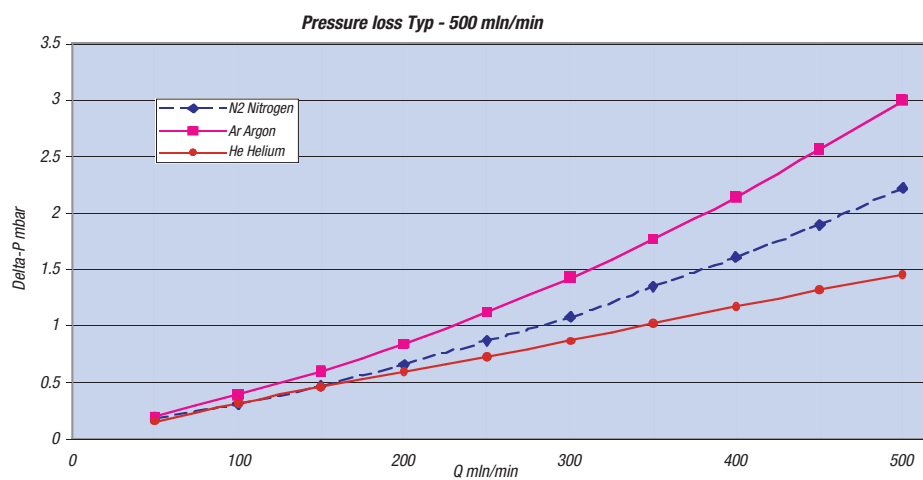


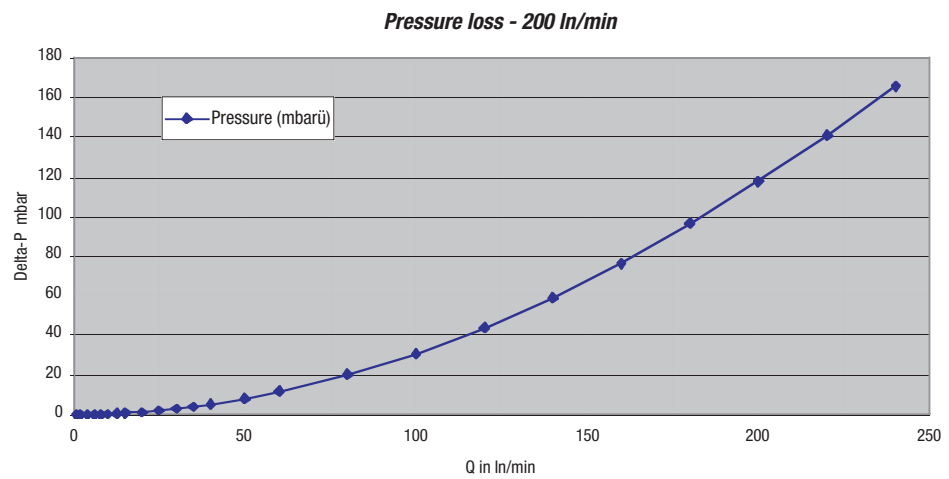
### Ansicht B / View B / Vue B



## 11 Annexe

## Pressure Loss





## Gas Conversion Factors

| Name                 | Chem. Symbol | Density(g/l)<br>0°C, 1 bar a | Conversion factor | Comments                          |
|----------------------|--------------|------------------------------|-------------------|-----------------------------------|
| Air                  | Air          | 1.293                        | 0.998             |                                   |
| Oxygen               | O2           | 1.429                        | 0.992             | absolutely free from oil & grease |
| Nitrogen             | N2           | 1.250                        | 1                 |                                   |
| Helium               | He           | 0.1785                       | ca. 9             |                                   |
| Argon                | Ar           | 1.784                        | 1.27              |                                   |
| Carbondioxide*       | CO2          | 1.977                        | 0.70              |                                   |
| Hydrogen             | H2           | 0.08991                      | ca. 10            |                                   |
| Methane              | CH4          | 0.7175                       |                   |                                   |
| Propane              | C3H8         | 2.012                        | 0.32              |                                   |
| Nitrousoxide         | N2O          | 1.978                        |                   |                                   |
| Sulfur Hexafluoride* | SF6          | 6.626                        |                   |                                   |
| Propylene            | C3H6         | 1.915                        |                   |                                   |
| Carbonmonoxide       | CO           | 1.25                         |                   |                                   |
| Butane               | C4H10        | 2.705                        |                   |                                   |

\*Valve with EPDM seals

The conversion factors given are approximative values and should only be used to determine a new range.

### Example

New range: 3 l/min CO2  
 Conversion factor: 0.70  
 Equivalent range with air:  $3 / 0.7 = 4,28$  l/min

# DB05

## Thermal mass flowmeter and controller for gases

- **Pressure and temperature-independent measurement**
- **Compact design, no need for straight pipe runs**
- **High degree of precision, short response time**
- **Analogue inputs and outputs for set and actual value, serial interface**
- **Turndown ratio up to 100:1**
- **Materials: aluminium or stainless steel**



### Description:

The DB04 thermal mass flowmeter and controller is modular system for measuring and regulating the flow of gases. The device can be supplied as a pure flowmeter, or with an integrated control valve with PI control function. In series production the DB05 has analogue current signals for the momentary flow and the set flow, as well as a serial interface via which the device can be programmed with user-friendly Windows software.

A variety of non-aggressive gases can be measured in measuring ranges from 0..25 ml/min to 0....200 l/min.

As a result of its modular structure, and due to the fact that it can be installed in any position and can be easily cleaned without the need for recalibration, the DB05 is suitable for the most varied applications, such as analysis devices, in the semiconductor industry, for pneumatic installations, lasers, welding systems or fuel cells.

Depending on the area of application, the device can be supplied with an aluminium or stainless steel casing as well as with a measuring accuracy of 1.5%, or as a precision instrument with an accuracy of 0.5%.

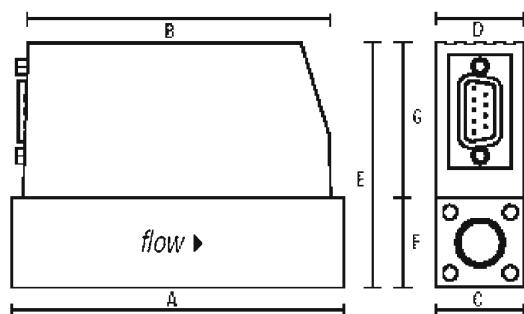


## Versions:

- DB05.MS:** Mass flowmeter  
Standard accuracy 1.5% f.s.d.
- DB05.CS:** Mass flowmeter and controller  
Standard accuracy 1.5% f.s.d.
- DB05.MH:** Mass flowmeter  
Increased precision 0.5% f.s.d.
- DB05.CH:** Mass flowmeter and controller  
Increased precision 0.5% f.s.d.

## Measuring ranges and dimensions:

| Version   | Con-<br>nection<br>(G IG) | A<br>(mm) | B<br>(mm) | C<br>(mm) | D<br>(mm) | E<br>(mm) | F<br>(mm) | G<br>(mm) |
|-----------|---------------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| DB05.M... | 1/4                       | 94        | 87        | 25        | 25        | 69        | 25        | 44        |
| DB05.M... | 1/2                       | 145       | 87        | 35        | 25        | 79        | 35        | 44        |
| DB05.C... | 1/4                       | 124       | 117       | 25        | 25        | 69        | 25        | 44        |
| DB05.C... | 1/2                       | 170       | 117       | 35        | 25        | 79        | 35        | 44        |



## Materials:

- DB05.x.x.A:** Aluminium casing, PBT sensor, Viton seal
- DB05.x.x.E:** Stainless steel casing, electropolished, PBT sensor, Viton seal

## Options:

- EPDM seals
- Actual value output and set value input  
0..20 mA, 0..5 V, 1..5 V, 0..10 V, 4..20 mA Namur
- Special measuring range for medium air, N<sub>2</sub>, O<sub>2</sub>
- Special measuring range for medium air,  
N<sub>2</sub>, O<sub>2</sub> (with real gas calibration)
- Other media (with air calibration)
- Other media (with real gas calibration)

## Ordering Code:

**Order no.:** DB05. MS. 01 A. 0. L

### Thermal mass flowmeter and controller for gases

#### Version

MS = Flowmeter, standard accuracy 1.5% f.s.d.  
CS = Flowmeter and controller,  
standard accuracy 1.5% f.s.d.  
MH = Flowmeter, increased accuracy  $\pm 0,3\%$   
of end value and  $\pm 0.5\%$  of actual value  
CH = Flowmeter and controller, increased accuracy  
 $\pm 0,3\%$  of end value and  $\pm 0.5\%$  of actual value

#### Measuring range (air):

- 01 = 0...25 Nm<sup>3</sup>/min, G 1 / 4 female  
02 = 0...50 Nm<sup>3</sup>/min, G 1 / 4 female  
03 = 0...100 Nm<sup>3</sup>/min G 1 / 4 female  
04 = 0...200 Nm<sup>3</sup>/min, G 1 / 4 female  
05 = 0...500 Nm<sup>3</sup>/min, G 1 / 4 female  
06 = 0...1 NI/min, G 1 / 4 female  
07 = 0...2 NI/min, G 1 / 4 female  
08 = 0...5 NI/min G 1 / 4 female  
09 = 0...10 NI/min G 1 / 4 female  
10 = 0...20 NI/min G 1 / 4 female  
11 = 0...50 NI/min G 1 / 4 female  
12 = 0...50 NI/min G 1 / 2 female  
13 = 0...100 NI/min G 1 / 2 female  
14 = 0...200 NI/min G 1 / 2 female

#### Material:

- A = Aluminium casing  
E = Stainless steel casing

#### Options:

- 0 = without  
E = EPDM seals  
IA = Actual value output deviating from standard (4...20 mA)  
SA = Set value input deviating from standard (4...20 mA)  
ES = Real gas calibration

#### Medium:

- L = Standard medium: air  
N = Standard medium: N<sub>2</sub>  
O = Standard medium O<sub>2</sub>  
S = Other media (please indicate in block letters)

## Technical data:

- Max. pressure:** 10 bar
- Medium temperature:** 0...50 °C
- Response time:** < 150 ms (DB05.C...)  
< 50 ms (DB05.M)
- Voltage supply:** 24V DC -5%/+ 10%
- Electrical connection:** D-sub plug, 9-pin
- Installation position:** up to 5 bar: any position,  
over 5 bar: horizontal